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The role of nursing in multimorbidity care

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Abstract

Background

Multimorbidity (the co-occurrence of two or more chronic conditions in the same person) affects around one in three persons, and it is strongly associated with a range of negative outcomes including worsening physical function, increased health care use, and premature death. Due to the way healthcare is provided to people with multimorbidity, treatment can become burdensome, fragmented and inefficient. In people with palliative conditions, multimorbidity is increasingly common. Better models of care are needed.

Methods

A mixed-methods programme of research designed to inform the development of a nurse-led intervention for people with multimorbidity and palliative conditions. A mixed-methods systematic review explored nurse-led interventions for multimorbidity and their effects on outcomes. A cross-sectional study of 63,328 emergency department attenders explored the association between multimorbidity, complex multimorbidity (≥3 conditions affecting ≥3 body systems), and disease-burden on healthcare use and inpatient mortality. A focussed ethnographic study of people with multimorbidity and life-limiting conditions and their carers (n=12) explored the concept of treatment burden.

Findings

Nurse-led interventions for people with multimorbidity generally focus on care coordination (i.e., case management or transitional care); patients view them positively, but they do not reliably reduce health care use or costs. Multimorbidity and complex multimorbidity were significantly associated with admission from the emergency department and reattendance within 30 and 90 days. The association was greater in those with more conditions. There was no association with inpatient mortality. People with multimorbidity and palliative conditions experienced treatment burden in a manner consistent with existing theoretical models. This thesis also noted the effect of uncertainty on the balance between capacity and workload and proposes a model of how these concepts relate to one another.

Discussion

This thesis addresses a gap in what is known about the role of nurses in providing care to the growing number of people with multimorbidity. A theory-based nurse-led intervention is proposed which prioritises managing treatment burden and uncertainty.

Conclusions

Nursing in an age of multimorbidity necessitates a perspective shift which conceptualises chronic conditions as multiple overlapping phenomena situated within an individual. The role of the nurse should be to help patients navigate the complexity of living with multiple chronic conditions.

Plain English summary

Advances in science and healthcare mean that people are living longer than ever before. This also means that more people are living longer with life-long diseases (like diabetes, heart failure or asthma) and other conditions which affect their health (like being overweight, having high blood-pressure or having difficulty moving about). Having two or more conditions or diseases is sometimes called multimorbidity.

People with multimorbidity are more likely to have trouble with their daily activities, to use healthcare services more frequently, and are more at risk of dying early. Because they may have to take lots of medicines, go to lots of appointments or do other things to stay healthy (like watching their diet and exercising), people with multimorbidity sometimes struggle with the burden of all these tasks.

This thesis aims to develop new ways for nurses to provide care to people with multimorbidity and palliative conditions. The word ‘palliative’ is often associated with cancer or being close to death; in this thesis it simply means a condition which will not be cured, and which will get worse (possibly over a very long time) until someone dies. In this way, conditions like heart failure, dementia, or chronic kidney disease are considered palliative conditions, while diabetes or asthma (which are generally life-long but stable) are not.

The thesis has three phases. In the first phase, we reviewed the scientific literature about nurse-led care for people with multimorbidity. In the second phase, we performed a statistical analysis of records for over 60,000 people who attended an emergency department in Glasgow, to see if multimorbidity and complex multimorbidity (having three or more conditions affecting three or more body systems) were associated with being admitted to the hospital, returning to the hospital within 30 or 90 days, or dying while admitted to the hospital. We also checked if the risk of these things happening increased depending on how many conditions a person had. In the final phase, we were interested in finding out about ‘treatment burden’, which is the work patients have to do to stay healthy. We interviewed people with multimorbidity and

palliative conditions and their carers, and asked them to keep journals of things they found difficult about their treatment.

From the literature, we found that nurse-led care for people with multimorbidity usually focussed on helping people deal with the complexity of having lots of conditions and treatments, rather than focussing on specific diseases. Patients were happy with these interventions, but they didn’t reliably reduce how often people had to use healthcare services, or the costs of healthcare.

In the study of people attending the emergency department, we found statistically significant associations between multimorbidity, complex multimorbidity, and being admitted to the hospital or returning within 30 or 90 days. This association was higher in people with more conditions. We did not find any significant association between multimorbidity, complex multimorbidity and dying while admitted to the hospital.

From speaking to people with multimorbidity and their carers, we found that their experience of treatment burden fits with existing scientific theories. How people cope depends on a range of factors, including their physical and mental health, support from friends and family, where they have to travel and how they get there, and how well they understand what it is they are supposed to do. We also found that people often struggled with uncertainty (about their health, about their treatment, about their emotions, about other people) and that this also made it more challenging to cope with their tasks.

From these results, we developed a model for how nurse-led care should be provided to people with multimorbidity and palliative conditions. It is important to help the right patients, so computer-based statistical models should identify people with multimorbidity who are at risk of struggling with treatment burden. The nurse providing care should focus on managing this burden and helping the patient cope with uncertainty. The patient should only be discharged from the intervention once the nurse, the patient, and their carers agree that their burden is at a level they can manage.

In conclusion, nurses can help improve care for people with multimorbidity by coordinating care, in a way that accounts for treatment burden and uncertainty.

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Author’s Declaration

I declare, that except where explicit reference is made to the contribution of others, this PhD thesis is the result of my own work and has not been submitted for any other degree at the University of Glasgow or any other institutions.

Chris McParland

Abbreviations

Abbreviation	Explanation
95% CI	Ninety-five percent confidence interval
ACP	Anticipatory care plan
ANP	Advanced Nurse Practitioner
aOR	Adjusted odds ratio
BMJ	British Medical Journal
CHF	Chronic heart failure
CHI	Community hospital index
CIRS	Cumulative Illness Rating Scale
CKD	Chronic kidney disease
CNS	Clinical Nurse Specialist
COPD	Chronic obstructive pulmonary disease
COSmm	Core outcome set for multimorbidity research
COVID-19	Coronavirus disease
ED	Emergency department
EMBARQUE	A focussed ethnography of treatment burden and burden for carers using reflexive qualitative methods
EPOC	Effective Practice and Organisation of Care (Cochrane group)
EQ-5D	EuroQoL 5 Dimension checklist
GP	General practitioner
GRADE	Grades of Recommendation, Assessment, Development and Evaluation
HIV	Human Immunodeficiency Virus
IAHPC	International Association for Hospice and Palliative Care
ICD-10	International Classification of Diseases 10
ICPC-2	International Classification of Primary Care version 2
ICT	Information and communications technology
ICU	Intensive care unit
IQR	Interquartile range
JBI	Joanna Briggs Institute
LPAC	Local Privacy Advisory Committee
MDT	Multidisciplinary team
MeSH	Medical Subject Heading
MRC	Medical Research Council
mRNA	Messenger ribonucleic acid
NHS	National Health Service
NHSGGC	NHS Greater Glasgow & Clyde
NIHR	National Institute for Health and Care Research

Abbreviation	Explanation
NPT	Normalisation Process Theory
NRS	National Records of Scotland
OPCS-4	Office of Population Censuses and Surveys, Fourth Revision
OR	Odds ratio
PPI	Patient and public involvement
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PROSPERO	International prospective register of systematic reviews
QEUH	Queen Elizabeth University Hospital (Glasgow)
R	R statistical programming language
R&I	Research and Innovation
RCT	Randomised controlled trial
REC	Research ethics committee
RECORD	The Reporting of Studies Conducted using Observational Routinely-collected Health Data
rTA	Reflexive thematic analysis
SATA	Specialist Assessment and Treatment Area
SE	Standard error
SIMD	Scottish Index of Multiple Deprivation
SMR01	Scottish Morbidity Record for general/acute inpatient and day case records
TB	Tuberculosis
TIA	Transient ischaemic attack
UK	United Kingdom
US/USA	United States/ United States of America
WHO	World Health Organisation

Chapter 1. Introduction

This thesis is concerned with the ways in which people with multiple chronic conditions interact with healthcare services, and the ways in which nurses can improve the quality of care these people receive. This introductory chapter will set out the extent of the problem posed by a growing population of people living with an increasing number of chronic conditions, particularly in the later stages of their life course. A broad overview will be provided of how the research programme described in this thesis sought to develop an intervention to improve care for this population. This chapter will also describe the structure of the thesis.

1.1 Research problem

Chronic (or non-communicable) disease is responsible for around 36 million (63%) global deaths each year, and reducing the avoidable burden of chronic disease has been one of the World Health Organisation (WHO)'s strategic priorities over the last decade (WHO, 2013). Mortality from chronic diseases such as cancer, cardiovascular disease, chronic respiratory disease and diabetes is a problem on a global scale, although patterns of mortality vary between countries and low and middle income nations experience higher rates of mortality (Bennett et al., 2020). The burden of chronic disease is also financial, accounting for significant economic disruption due to lost productivity (Schofield et al., 2016), and consuming the majority of healthcare expenditure in both high-income (Waters and Graf, 2018) and low/middle income countries (Abegunde et al., 2007).

At the individual level, living with chronic illness can mean coping with symptoms such as pain and breathlessness, or engaging with prescribed treatments. However, it also places a cognitive burden on the individual, requiring acceptance of the new state, learning to cope with the effects of illness, or developing strategies to self-manage aspects of the condition, all with the end goal of adapting to the new normality which the disease affects (Ambrosio et al., 2015).

Chronic diseases do not occur in isolation. In a synthesis of studies from 51 countries, the prevalence of people living with two or more concurrent chronic conditions was estimated at 33.1% (95% confidence interval (95% CI): 30.0–36.3%) (Nguyen et al., 2019a). The term used to describe living with two or more chronic conditions is multimorbidity (van den Akker et al., 1996).

Multimorbidity is associated with increased mortality (Jani et al., 2019), increased healthcare utilisation (Barnett et al., 2012), and despite placing significant financial strain on those living with multiple chronic conditions (Larkin et al., 2021), it can be difficult for health services to stratify risk for this population in a cost-effective manner (Stokes et al., 2021). Advanced age and lower socioeconomic status are also strongly associated with higher multimorbidity prevalence (Barnett et al., 2012). Despite this prevalence, health systems are predominantly arranged around the management of single diseases, and tend towards operating in silos rather than collaboratively across disciplines (Hajek, 2013). Navigating complex and potentially conflicting guidance from multiple specialties can result in care that is fragmented and burdensome (Boyd et al., 2014), leading to worsening outcomes in an already poorly-served population (May et al., 2014; Gallacher et al., 2013; Shippee et al., 2012).

1.2 Research context

The research programme described in this thesis was undertaken by the author as part of a full time PhD studentship funded primarily by the local National Health Service (NHS) board, NHS Greater Glasgow and Clyde (NHSGGC), in Glasgow, Scotland.

Scotland has a population of approximately 5.48 million people (Office for National Statistics, 2021), and a geography which ranges from large urban centres primarily in the central belt, to more rural communities predominantly in the highlands and islands. NHSGGC employs approximately 43,500 staff and is responsible for the care of 1.3 million people residing in Scotland’s most populous city and its surrounding areas (NHSGGC, 2023).

Healthcare in the United Kingdom (UK) is provided by the NHS, a taxpayer-funded organisation founded on the principle of providing universal, centrally-funded and equitable care which is free to the user at the point of delivery (Delamothe, 2008). Following the establishment of a Scottish Parliament in 1998 and the devolution of powers previously held by the UK Government, the Scottish Government assumed responsibility for legislature related to healthcare, and NHS Scotland assumed responsibility for the provision of care for Scotland's citizens (Health Financial Management Association (HFMA), 2023). There are 14 regional health boards in Scotland, with NHSGGC being the largest in terms of staff and the population it serves (NHSGGC, 2023).

Glasgow has earned a reputation as a public health anomaly when compared with ostensibly similar post-industrial cities in the UK. Over the past 20 years, a wealth of research and discussion has sought to explain the 'Glasgow effect' – a term used to describe the disproportionately lower life expectancy of people in Glasgow when compared with similarly deprived areas (Reid, 2011). Debate surrounds the exact causes of this premature mortality, although it is likely a complex interplay of social, economic, and behavioural factors (Fraser and George, 2015). McCartney et al. (2011) collated and evaluated proposed hypotheses for the Glasgow effect (and broader 'Scottish effect', when compared with the rest of Europe) into a conceptual model, reproduced in Figure 1-1.

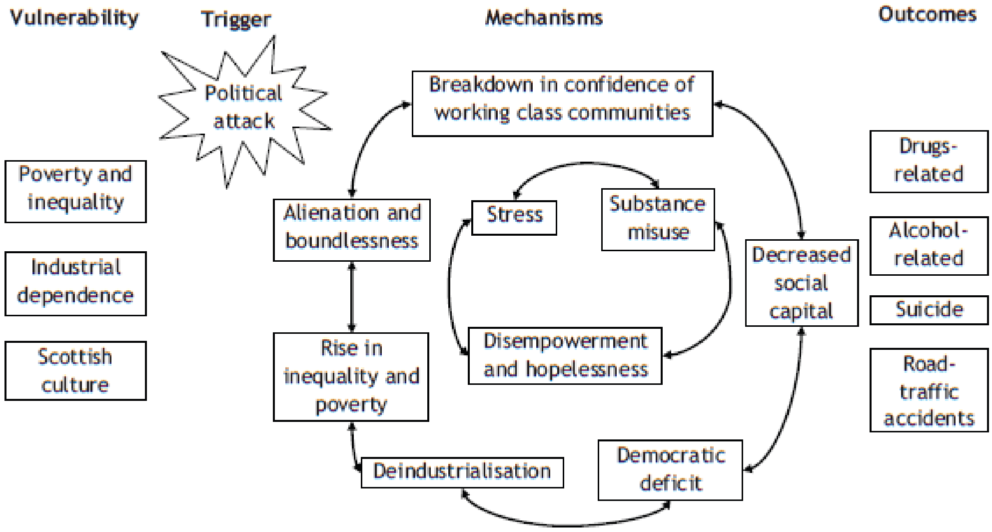


Figure 1-1: Simplified synthesis of the cause of the Scottish and Glasgow Effect. Reproduced from McCartney et al. (2011).

In their synthesis, the authors outline pre-existing vulnerabilities which were triggered by the 'neoliberal political attack' of the 1980s. This caused greater harm to Glasgow and Scotland than other similar parts of the UK due to higher levels of social housing, industrial employment, and other factors. This in turn leads to a cascade of mechanisms which enable outcomes driving excess mortality, including drug, alcohol and road traffic related deaths, as well as suicide (McCartney et al., 2011). While this analysis deals directly with the problem of excess mortality rather than the general health of the population, it provides a valuable illustration of Glasgow as a unique setting, and one in which myriad factors with the potential to drive poor health are at play.

1.3 Scope and terms of the research

The preceding information is not intended to limit the scope of this thesis; it simply serves to ground the research in the cultural and social context in which it was conducted. Patterns of chronic disease and resultant mortality vary between countries and health systems (Bennett et al., 2020), and the nature of multimorbidity is no exception. The conditions which drive multimorbidity differ between nations; conditions such as tuberculosis (TB) or human immunodeficiency virus (HIV) are more prevalent in low or middle-income countries (Abebe et al., 2020), but largely absent in the majority of multimorbidity research which comes from high income nations (Xu et al., 2017). The tools which researchers use to measure multimorbidity are also often geographically limited, focussing on conditions prevalent within that particular area (Stirland et al., 2020). Even within the same country, variations in factors such as urban or rural settings and altitude may contribute to differences in observed patterns of multimorbidity (Miranda et al., 2019).

The aim then of this thesis is to focus on multimorbidity itself, and the experience of living with multiple chronic conditions without necessarily focussing on what those conditions are. In doing so, it is intended to present findings which may be relevant beyond the local context in which this research has been conducted.

1.3.1 Terms of the research

It is important too, to be clear from the outset what is meant by terms such as multimorbidity. The historical and social context of how disease and multimorbidity is conceptualised is discussed in the following chapter, but the definitions employed will be set out here first.

1.3.1.1 Definition of multimorbidity

Multimorbidity, in the context of this thesis, is defined as:

> The co-occurrence of two or more chronic conditions in the same individual, where no condition holds precedence over the others.

This definition is based on the work of van den Akker et al. (1996), who made the key distinction between multimorbidity (as defined above) and comorbidity, in which conditions are considered comorbid to an index condition (Feinstein, 1970). The phrase comorbidity is used on occasion in this thesis, but only when describing conditions with reference to an index condition, or when discussing conditions which can be considered to be ‘comorbid’ to one another.

The concept of chronic conditions also requires some clarity. From a theoretical and patient-oriented standpoint, risk factors (such as hypertension) and symptoms (such as back pain) contribute towards the complexity and burden which comprise multimorbidity, but from an epidemiological standpoint it may be preferable to consider only diagnosed chronic diseases (Willadsen et al., 2016). In this thesis, a holistic approach which includes risk factors and symptoms will be taken, except where quantitative measurement of conditions is required (i.e., in the cross-sectional study).

In the cross-sectional study there is also mention of ‘complex multimorbidity’. This term is again used differently in different contexts, but in this thesis it is used to describe having three or more chronic conditions which affect three or more body systems. This definition and the means of identifying complex multimorbidity is based on work by Harrison et al. (2014).

1.3.1.2 Definition of nurse-led care

Nurse led care is a poorly defined concept (Schmüdderich et al., 2023), therefore a working definition was developed. In this thesis, nurse-led care was defined as care which was provided by either:

1. A service led by a (possibly consultant) nurse, as opposed to a medically led service.

2. A nurse with a caseload of patients for whom they are continuously responsible, as opposed to shift or area-based nursing.

3. A nurse who practices with a discernible degree of autonomy and has advanced clinical and decision-making skills, when compared with nurses providing medically led care.

The working definition was intended to be inclusive enough to capture a broad range of interventions. This is discussed further in Chapter 2.

1.3.1.3 Definition of palliative care

Throughout the thesis, reference is made to palliative conditions or people with palliative care needs. It is important to be clear what is meant by this. Palliative care is often conflated with end-of-life care, despite its ‘upstream migration’ to patients who have a life-limiting, life-threatening or serious illness but for whom death is not necessarily imminent (Ryan et al., 2020). The definition of palliative care which will be used in this thesis is by the International Association for Hospice and Palliative Care (IAHPC), the main point of which is that:

> Palliative care is the active holistic care of individuals across all ages with serious health-related suffering due to severe illness, and especially of those near the end of life. It aims to improve the quality of life of patients, their families and their caregivers. (IAHPC, 2019)

This definition does not exclude end-of-life care, but importantly it emphasises that palliative care relates to the management of severe illness throughout the life course. When the term ‘palliative care needs’ is used in this thesis, it does not mean ‘end-of-life care needs’, it refers to the needs of people with severe and potentially life-limiting illnesses such as cancer, heart-failure, or dementia. When the term ‘palliative conditions’ is used, it means conditions such as those described above, which will get progressively worse and will likely lead to an individual’s death. Conditions such as chronic kidney disease or cancer are included in this definition, although it should be noted that these may not be the reason for an individual’s death (in the case of milder forms of chronic kidney disease), or they may be curable (in the case of many cancers). Where a condition is often but not exclusively considered palliative, the thesis errs on the side of inclusivity.

1.4 Research objectives and questions

1.4.1 Research objectives

The thesis sought to address four overarching objectives. The first is the primary objective of the thesis as a whole, and the following three relate to the phases of the research described therein.

1.4.1.1 Primary objective

- To develop a nurse-led intervention to improve the quality of care for people with multimorbidity and palliative conditions

1.4.1.2 Secondary objectives

1) To establish what types of nurse-led interventions have been evaluated, and what outcomes they improve

2) To determine if there is a significant association between multimorbidity, healthcare use and inpatient mortality in emergency department attenders

3) To explore how people with multimorbidity and palliative conditions, and the people who care for them, experience treatment burden

1.4.2 Research questions

The research questions relate to the secondary objectives above and are addressed by the phases of the research programme described in this thesis. They are presented here with reference to the objectives to which they relate

(1.a.) What nurse-led interventions for people with multimorbidity are described in the published literature?

(1.b.) What effects do these interventions have on outcomes, and what evidence is there of their benefit?

(2.a.) In people attending the emergency department (ED), is multimorbidity significantly associated with (i) admission, (ii) 30-day reattendance, (iii) 90-day reattendance, and (iv) inpatient mortality?

(2.b.) In people attending the ED, is complex multimorbidity significantly associated with (i) admission, (ii) 30-day reattendance, (iii) 90-day reattendance, and (iv) inpatient mortality?

(2.c.) In people attending the ED, does the risk of (i) admission, (ii) 30-day reattendance, (iii) 90-day reattendance, and (iv) inpatient mortality increase with a greater number of chronic conditions?

(3.a.) What common healthcare tasks and responsibilities are perceived as burdensome by people with multimorbidity and palliative conditions, and their carers?

(3.b.) From the perspective of people with multimorbidity and palliative conditions and their carers, what are the priorities for improving care and reducing treatment burden?

(3.c.) What role do carers play in supporting people with multimorbidity and palliative conditions, and how do they help to manage treatment burden?

1.5 Structure of the thesis

The thesis is structured in a way that sequentially addresses the research questions above, before addressing the primary objective. Table 1-1 summarises where in the thesis these objectives and questions are addressed.

Objective	Questions	Location
To establish what types of nurse-led interventions have been evaluated, and what outcomes they improve	What nurse-led interventions for people with multimorbidity are described in the published literature? What effects do these interventions have on outcomes, and what evidence is there of their benefit?	Chapter 5
To determine if there is a significant association between multimorbidity, healthcare use and mortality in emergency department attenders	In people attending the ED, is multimorbidity significantly associated with (i) admission, (ii) 30-day reattendance, (iii) 90-day reattendance, and (iv) inpatient mortality? In people attending the ED, is complex multimorbidity significantly associated with (i), (ii), (iii), and (iv)? In people attending the ED, does the risk of (i), (ii), (iii), and (iv) increase with a greater number of chronic conditions?	Chapter 6
To explore how people with multimorbidity and palliative conditions, and the people who care for them, experience treatment burden	What common healthcare tasks and responsibilities are perceived as burdensome by people with multimorbidity and palliative conditions, and their carers? From the perspective of people with multimorbidity and palliative conditions and their carers, what are the priorities for improving care and reducing treatment burden? What role do carers play in supporting people with multimorbidity and palliative conditions, and how do they help to manage treatment burden?	Chapter 7
To develop a nurse-led intervention to improve the quality of care for people with multimorbidity and palliative conditions	NA	Chapter 8

Table 1-1: Summary of thesis structure with reference to where objectives and research questions are addressed.

1.5.1 Chapter summaries

The following is a summary of what is discussed in each chapter. In this introduction (Chapter 1), a brief description of the research problem and context has been provided, alongside a definition of terms and the research questions to be addressed.

Chapter 2 provides more in-depth background related to the concepts of multimorbidity and nurse-led care, alongside a summary of the state of the science in multimorbidity research.

Chapter 3 outlines the theoretical framework which has guided the research, and discusses the literature pertaining to the methods employed in the thesis.

Chapter 4 describes the methods employed in the three phases of the research.

Chapter 5 presents the findings of a mixed-methods systematic review which describes different types of nurse-led interventions for people with multimorbidity, and identifies what outcomes were improved by such interventions.

In Chapter 6, the result of a cross-sectional study of ED attenders is reported. The study aimed to establish if there was a significant association between multimorbidity and negative outcomes such as death and healthcare usage.

Chapter 7 reports a focussed ethnographic study of people with multimorbidity and those who care for them. The study explored the concept of treatment burden, and how best to provide care without causing unnecessary burden.

In Chapter 8, the findings of the preceding three chapters are summarised and discussed in relation to the published literature. A potential model of a nurse-led intervention for people with multimorbidity and palliative conditions is outlined.

Finally, Chapter 9 draws together conclusions for researchers, policy makers, and clinical practitioners.

Chapter 2. Background

2.1 Introduction

This chapter provides some historical and social context for how diseases and multimorbidity are conceptualised, and how the nursing profession has developed in order to meet the changing needs of society. It concludes by reviewing current issues in multimorbidity research.

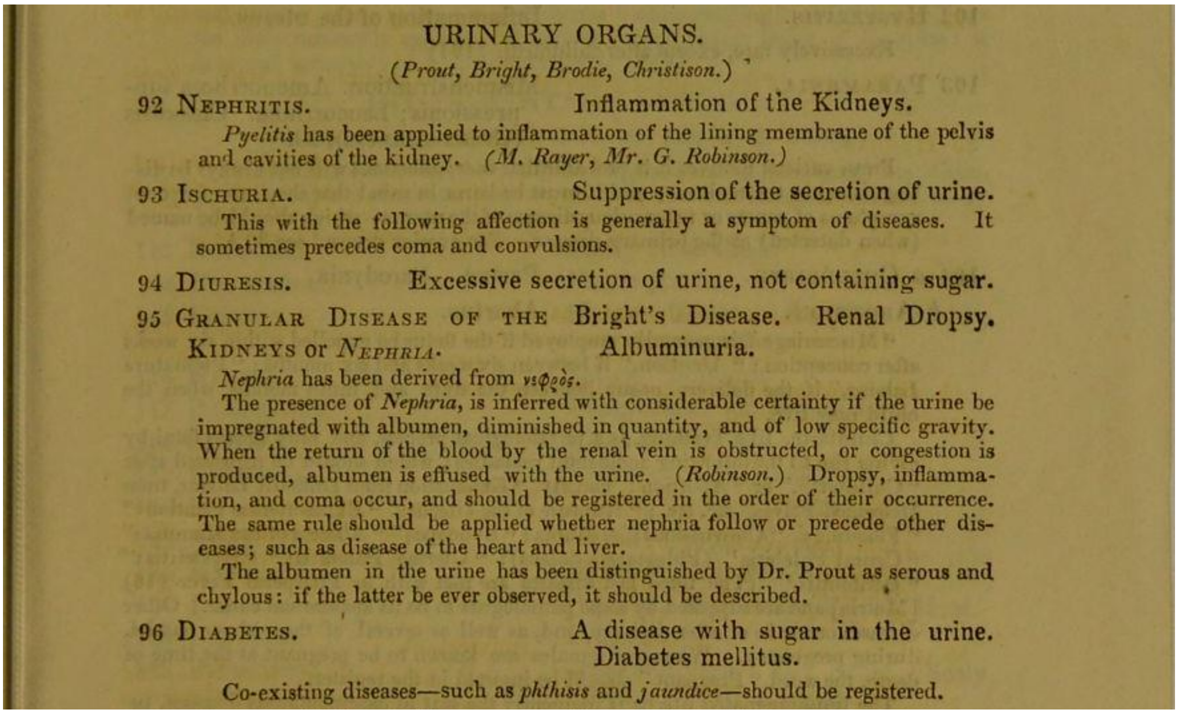
2.2 Humours, nosologies and topographies: multiple perspectives on disease

> The course is the common one, namely, the kidneys and the bladder; for the patients never stop making water, but the flow is incessant, as if from the opening of aqueducts... The nature of the disease, then, is chronic, and it takes a long period to form; but the patient is short-lived, if the constitution of the disease be completely established; for the melting is rapid, the death speedy. Moreover, life is disgusting and painful; thirst, unquenchable; excessive drinking, which, however, is disproportionate to the large quantity of urine…
>
> Aretaeus of Cappadocia (2nd Century AD), from (Laios et al., 2012, p. 111)
>
> The most common symptoms of type 1 diabetes mellitus are polyuria, polydipsia, and polyphagia, along with lassitude, nausea, and blurred vision, all of which result from the hyperglycaemia itself. Polyuria is caused by osmotic diuresis secondary to hyperglycaemia. Severe nocturnal enuresis secondary to polyuria can be an indication of onset of diabetes in young children. Thirst is a response to the hyperosmolar state and dehydration.
>
> Type 1 diabetes clinical presentation from Medscape.com (Khardori, 2023)

Treating the structural and functional disorders of the body requires a conceptualisation of what is meant by disease. As the quotations above illustrate, the effort to classify and locate such disorders, to understand their causes and to predict their course has been part of human culture for millennia. Yet the lens applied by the observer changes over time, as do the tools at their disposal. Aretaeus’ account is notable for being comprehensive in its description of the external signs of diabetes and its (at the time, unfortunately inevitable) course (Laios et al., 2012). His speculative description of diabetes as a condition in which the internal matter of the body is melted down and excreted as urine (Karamanou et al., 2016), while incorrect, is understandable given that his observation of the disease was limited to what external abnormalities could be seen by the naked eye: people became unwell, excreted vast amounts of urine, were tormented by an unquenchable thirst, and ultimately died. It is only with technological developments and through scientific investigation that the contemporary understanding of diabetes (as a metabolic condition resulting from the dysfunction of specific organs and systems) can be arrived at.

The journey from Aretaeus' external survey to contemporary scientific understanding and classification of disease has involved several reconfigurations of how diseases are understood. From before the time of Aretaeus through to the medieval period, medical thought was built on the Hippocratic belief that an imbalance of the four 'humours' of the body (blood, phlegm, yellow and black bile) was the cause of disease (McCall, 2016). By the 18th century, diseases were organised in abstract nosological tables; classifications based on the external signs and symptoms which they had in common, diseases arranged by class and order as with the nosological tables of Sauvages (1785) and Linnaeus (1763) (see Figure 2-1). Medical classification in 19th Century Europe continued this focus on classification, but moved towards nosologies based upon the anatomical locus of disease, rather than the observed symptoms; a decision driven by the need to identify the cause of disease in order to facilitate treatment or for accurate record keeping (Shorter, 2015) (see Figure 2-2). A working knowledge of anatomy and the links between internal structures and external observations was emerging, providing the observer with tools which were unavailable to Aretaeus.

Figure 2-1: Excerpt from Carl Linnaeus' Genera Morborum (1763).
Disease (Morbi) are divided into those which produce fever (febriles) and those which do not (temperati), before being subcategorised down to the level of individual diseases. Diabetes, for example, can be classified (in descending order) as: morbi > temperati > fluidi > secretionis > evacuatorii > genitalium > diabetes. The anatomical locus only features in the second lowest category (genitalium).



URINARY ORGANS.

(*Prout, Bright, Brodie, Christison.*)

92 NEPHRITIS. Inflammation of the Kidneys.

Pyelitis has been applied to inflammation of the lining membrane of the pelvis and cavities of the kidney. (*M. Rayer, Mr. G. Robinson.*)

93 ISCHURIA. Suppression of the secretion of urine.

This with the following affection is generally a symptom of diseases. It sometimes precedes coma and convulsions.

94 DIURESIS. Excessive secretion of urine, not containing sugar.

95 GRANULAR DISEASE OF THE KIDNEYS or *NEPHRIA*. Bright's Disease. Renal Dropsy. Albuminuria.

Nephria has been derived from νεφρὸς.

The presence of *Nephria*, is inferred with considerable certainty if the urine be impregnated with albumen, diminished in quantity, and of low specific gravity. When the return of the blood by the renal vein is obstructed, or congestion is produced, albumen is effused with the urine. (*Robinson.*) Dropsy, inflammation, and coma occur, and should be registered in the order of their occurrence. The same rule should be applied whether nephria follow or precede other diseases; such as disease of the heart and liver.

The albumen in the urine has been distinguished by Dr. Prout as serous and chylous: if the latter be ever observed, it should be described.

96 DIABETES. A disease with sugar in the urine. Diabetes mellitus.

Co-existing diseases—such as *phthisis* and *jaundice*—should be registered.

Figure 2-2: Excerpt from a statistical nosology relating to the causes of death (1843).
In the hierarchy, diabetes is now classified as (in descending order): sporadic diseases of special systems and organs > urinary organs > diabetes. All diseases are linked to an anatomical structure or system. Also noteworthy is the recommendation to register co-existing diseases.

In *The Birth of the Clinic*, Michel Foucault uses a similar device to the quotations presented at the start of this section, to illustrate the way medical perception has shifted through time. Foucault's concept of the 'medical gaze' is used to describe the way that clinical observations are organised to fit within an existing framework which allows diseases to be recognised, and for information which is deemed irrelevant to be discarded (Foucault, 1973). He emphasises the way that disease has been ‘spatialised’ on three levels throughout history: at the primary abstract level of diseases themselves, at the secondary level of diseases located topographically within the body, and at the tertiary level of the institutions in which disease is organised at a social level, for example in hospitals and clinics (Philo, 2000).

The topographical conceptualisation of disease has been the predominant one for most of medical history, and it has contributed to the tertiary spatialisation of how diseases are managed in society. The emergence of specialism in medical practice is a complex history of its own, but the salient point is that by the 19th century the sum of medical knowledge was such that true mastery required the clinician to focus on a particular area of practice, which ultimately leads to the consultant-led medical and surgical specialties of today (Weisz, 2003). In the UK as is the case in most countries, chronic conditions are managed by specialties which operate within the parameters of specific anatomical structures and bodily systems (Whitty and Watt, 2020), such as cardiology or respiratory medicine. Others are concerned with the tissues affected (histological) as is the case with certain cancers. Some services are structured around symptoms or risk factors, such as incontinence or falls (Jakob, 2017). Contemporary nosologies such as the International Classification of Diseases 10 (ICD-10) are structured by chapters at the topographic level (VI: Diseases of the nervous system, XI: Diseases of the digestive system), the phenotypical level (I: Certain infectious and parasitic diseases, II: Neoplasms, V: Mental and behavioural disorders), temporally (XVI: Certain conditions originating in the perinatal period), or by aetiology (I: Certain infectious and parasitic diseases, XIX: Injury, poisoning and certain other consequences of external causes, XX: External causes of morbidity and mortality).

The point demonstrated here is that multiple perspectives of disease coexist, not only during the time of Aretaeus, Sauvages, Linnaeus, or Foucault, but that they persist in contemporary healthcare. What matters is that the lens which is applied by the clinician or researcher is appropriate to the situation, and that multiple lenses and perspectives do not contradict or duplicate the work of one another when confronted by multiple diseases in the same person.

2.2.1 Multimorbidity

The coexistence of two or more chronic conditions in the same person (or multimorbidity) is a growing problem- one which affects an ever-greater proportion of society yet until recent years has garnered relatively little attention from the scientific community. Diseases are often considered to co-occur randomly, however, returning to the example of diabetes it is possible to consider how shared pathophysiological processes and risk factors can result in patterns of disease (Whitty and Watt, 2020).

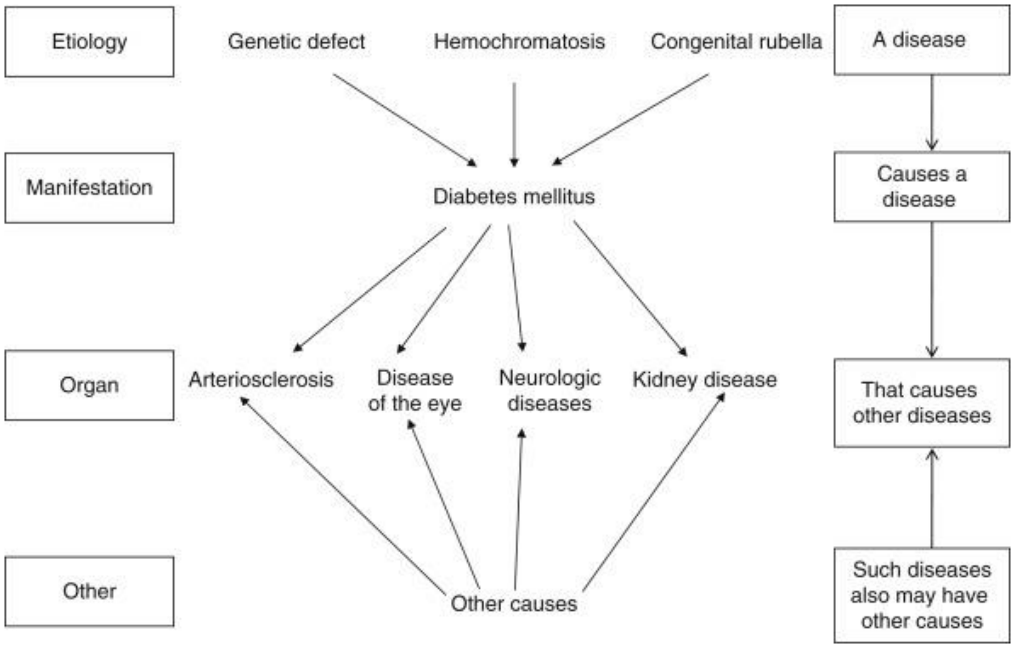


Figure 2-3: Challenges associated with disease classification. From Jakob (2017).

In Figure 2-3, the aetiology of diabetes includes other diseases (haemochromatosis and congenital rubella), and the effects of diabetes include more diseases of the vascular, neurological and renal systems. The model also recognises the potential for other unseen causes to impact on the manifestation of these diseases (Jakob, 2017). Diabetes is a well-understood example of how a disease is precipitated by other diseases, and in turn leads to further disease, yet there are likely many others which are as-yet undetected (Whitty and Watt, 2020). Diseases may also cluster for a range of other reasons, such as shared risk factors (e.g., smoking), in advanced age, or due to single organ dysfunction triggering multiple pathologies (van den Akker et al., 1996).

The emergence of multimorbidity as a distinct theoretical concept is relatively recent. The term ‘comorbidity’ was coined by Alvan Feinstein in 1970, who acknowledged that failure to collect information on secondary conditions (or comorbidities) risked compromising medical statistics and evaluations of treatment efficacy:

> …sick people usually receive strictly one-disease classifications that ignore the co-morbidity of other diseases occurring in addition to the index disease under consideration. (Feinstein, 1970, p. 455)

The ‘index disease’ mentioned here is important. In a patient with multiple diseases, the index disease is determined by the clinician or investigator; for example, on encountering a patient a cardiologist will consider heart failure as the primary disease, with comorbid chronic kidney disease. A renal physician will arrive at the opposite conclusion. The patient is materially unchanged, it is the lens through which they are perceived which shifts.

This is where a distinction can be made between comorbidity and multimorbidity. Marjan van den Akker and colleagues’ 1996 review sought to differentiate between these two similar and often conflated terms- where comorbidity assumes the presence of an index condition in the manner of Feinstein (1970), and multimorbidity simply refers to any coexistence of diseases in the same individual, including chronic or acute diseases and other medical conditions (van den Akker et al., 1996). An alternative concise definition of multimorbidity is offered by Boyd and Fortin (2010):

> Multimorbidity is …the co-existence of two or more chronic conditions, where one is not necessarily more central than the others. (Boyd and Fortin, 2010, p. 453)

Figure 2-4 provides a visual representation of how the application of a comorbidity framework differs from a multimorbidity framework. In both cases a patient with four conditions is presented, but in a comorbidity framework these conditions are distinct, and one holds precedence over the others. In a multimorbidity framework these are equal and overlapping, and conceptualised within the patient (Boyd and Fortin, 2010).

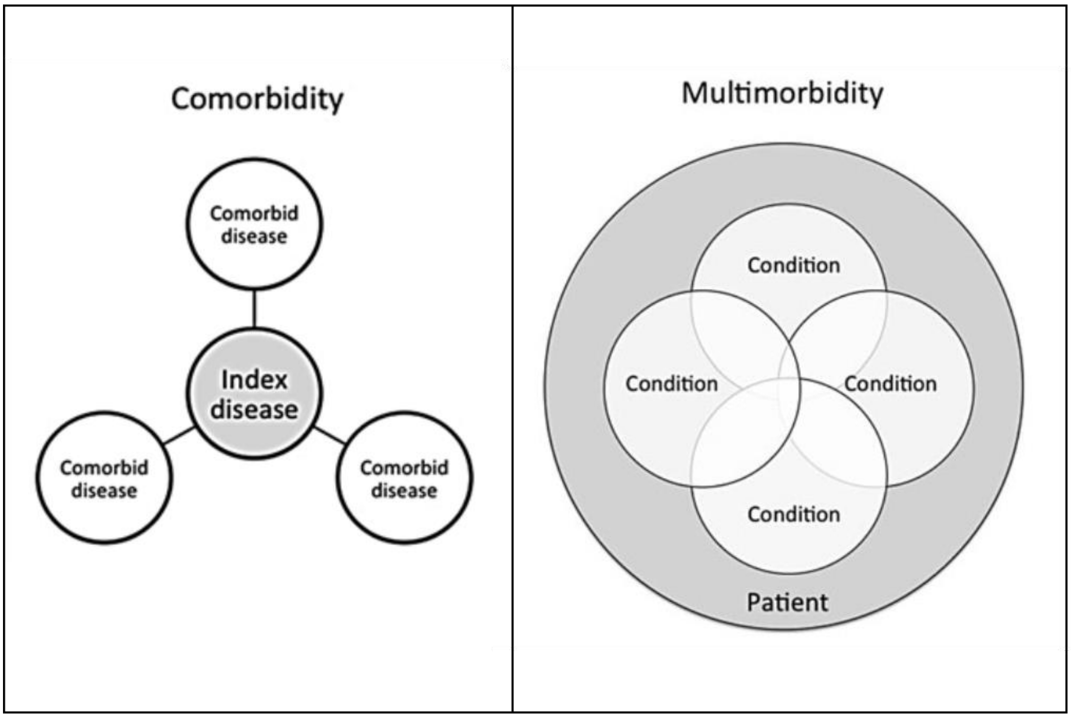


Figure 2-4: Difference between comorbidity framework and multimorbidity framework. Composite from Boyd and Fortin (2010).

Another distinction relates to the use of the words ‘disease’ and ‘condition’. As discussed above, perceptions of disease have changed throughout human history, and even now it can be difficult to assign this category to some of the factors which comprise multimorbidity. Conditions such as dyspepsia, migraines, disordered sleep, falls, or a hearing impairment are not generally considered diseases, but may play a significant role in how someone experiences multimorbidity (Boyd and Fortin, 2010). In a systematic review of multimorbidity definitions, Le Reste et al. (2013) identified criteria which included not only acute and chronic diseases, but also biopsychosocial and somatic risk factors, ability to cope, burden of diseases, health care consumption, disability, quality of life, and frailty, amongst others. In another systematic review, a significant proportion of papers included risk factors (85%, n=98 studies) and symptoms (62%, n=71) in their definition of multimorbidity (Willadsen et al., 2016).

What this reveals is that the term multimorbidity is used to describe having two or more chronic conditions, where no condition is more central than the others (Boyd and Fortin, 2010; van den Akker et al., 1996), and that the conditions which constitute multimorbidity can include diseases alongside symptoms and risk factors (Le Reste et al., 2013; Willadsen et al., 2016). This thesis has been guided by this definition.

2.3 The role of nursing and nurse-led care

> Pathology teaches the harm that disease has done. But it teaches nothing more. We know nothing of the principle of health, the positive of which pathology is the negative, except from observation and experience. And nothing but observation and experience will teach us the ways to maintain or bring back the state of health.
>
> Excerpt from *Notes on Nursing,* by Florence Nightingale (1860, p. 76)

> At the point of registration, the registered nurse will be able to… demonstrate and apply knowledge of body systems and homeostasis, human anatomy and physiology, biology, genomics, pharmacology and social and behavioural sciences when undertaking full and accurate person-centred nursing assessments and developing appropriate care plans.
>
> Excerpt from the UK Nursing and Midwifery Council's *Standards of Proficiency for Registered Nurses,* (2018, p. 14)

The emergence of the modern nursing profession began during the Crimean War, and the codification of what is arguably the first grand theory of nursing science (Higgins and Moore, 2000) came in the form of Florence Nightingale's *Notes on Nursing* (1860). It may seem an unfair representation of Nightingale's pioneering work in what would now be understood as evidence-based practice (Mackey and Bassendowski, 2017) to present an excerpt in which knowledge of pathology and the biomedical is marginalised. It is also important to remember that Nightingale's intended audience didn't enjoy the same access to education and training as the nursing workforce of today, nor would they be considered (or have considered themselves) as professional nurses. Nonetheless, the clear delineation between the nursing act and the science of medicine which existed at the time of Nightingale has diminished with time, and in many areas of contemporary practice nurses are increasingly responsible for tasks which would have traditionally been the responsibility of a doctor (Laurant et al., 2018).

However, this raises the question of what nursing is if not defined in relation to medicine? Historically, nursing was understood by its place in a hierarchy, subservient to medicine. During the 20th century the nursing profession evolved;

as Allan (2016) notes, nursing became a registered profession in the UK in 1919, and in the decades which followed various attempts were made to distinguish it from the medical profession, including through the adaption of symbols from medicine (such as nursing diagnoses) or through the development of epistemologies related specifically to the acquisition of nursing knowledge. Many such developments did not become embedded in routine practice, but formed part of "an overall professionalising strategy, with some [developments] rooted in the particular times and cultures where they were devised" (Allan, 2016, p. 60).

Some of the more material changes to nursing practice and the nursing profession took place towards the end of the 20th century. Nurse-led clinics first emerged in the nursing literature in the 1980s and 1990s, initially providing care to patients with chronic illnesses in a protocolised manner and prescribing medication with delegated responsibilities through patient group directives. These clinics grew in scope with nurses eventually seeing, diagnosing and treating undifferentiated patients, often in ambulatory care settings (Hatchett, 2003). Ethnographic research from this period suggests that doctors and nurses of the time operated with broadly aligned ethical principles, the exception being that nurses tended to prioritise patient autonomy over beneficence of treatment, while doctors prioritised beneficence (Robertson, 1996). In a special issue of the British Medical Journal (BMJ) which sought to address the need for doctors and nurses to work together more collaboratively, an editorial reflected that both professions were still weighed down by tradition and traditional gender roles in relation to each other (Davies, 2000).

There were, however, models which managed to encapsulate how nurse-led care could be organised to the benefit of patients without simply co-opting tasks and practices from medicine. Inpatient nursing development units emerged in the 1980s in the UK, and operated using a primary nursing model in which an individual nurse was responsible for the planning and implementation of care for a patient continuously, delegating work to others for when they were off duty. The units were nurse-led, as the patients who were admitted had a primary need for nursing care rather than medical intervention, although they were also staffed by doctors and other healthcare professionals to ensure patients' needs were met (Pearson, 1988). Continuous allocated primary nursing is not feasible in every context, neither financially nor practically. However, it provides a model which emphasises the therapeutic value of the nursing act. Therapeutic nursing differentiates the prerogative to provide care from the biomedical aim to cure, but without the passive connotations sometimes associated with 'caring'(McMahon, 1991).

Developments in nursing practice in the 21st century have mostly been in relation to the advancement of nursing roles and in the extension of nursing practice into traditionally medical spaces, rather than in developing new models of nursing. These developments were accompanied by an expansion in the number of nurses undertaking more advanced roles, such as clinical nurse specialists (CNSs) and advanced nurse practitioners (ANPs). There is significant variation in how these titles are used internationally, although ANPs tend to have more broad and generalised expertise, while the CNS role is more focussed and specialised (Cooper et al., 2019). There was also an expansion in the number of nurse practitioners, an older role which first emerged in the United States of America (US/USA) in the 1960s (Hatchett, 2003). Nurse practitioners can be found in a variety of clinical specialties, notably in emergency care where emergency nurse practitioners have been shown to have a positive impact on the quality of care, patient satisfaction, and waiting times (Jennings et al., 2015). The expansion of advanced nursing roles (particularly advanced nurse practitioners in the UK) into primary care has also been extensive, and a recent Cochrane review indicates that nurses likely have a positive effect on satisfaction and some health related outcomes, but may take longer in consultations and potentially generate a slightly higher volume of return visits (Laurant et al., 2018). A major development in this expansion of nursing roles has been non-medical prescribing by nurses, with another Cochrane review finding that non-medical prescribing in primary and secondary care delivers comparable quality in a range of outcomes, although there is limited evidence on how it impacts the number of adverse events (Weeks et al., 2016).

2.4 The current landscape: nursing and multimorbidity care

The aim of this chapter so far has been to set out the historical and social context for both multimorbidity and nursing practice. Before moving on to review current issues related to multimorbidity research, it is important to summarise this context.

Multimorbidity is not the exception but the norm in contemporary nursing and healthcare. In many areas of healthcare, nurses and other professionals should perceive patients through a multimorbidity lens, in which multiple conditions are understood in the context of the person and without the imposition of any central disease or process to which the others are considered comorbid. Throughout the history of medicine, various perspectives on how diseases are perceived have coexisted, and this is still the case in contemporary practice. An ageing population living longer with more diseases necessitates this shift in perspective.

Perceptions of the nursing profession have similarly shifted, and while there has been a trend towards advanced clinical skills and biomedical models of practice, the therapeutic act of nursing remains a constant. In an age of multimorbidity, person-centred and therapeutic nursing care as part of an interdisciplinary effort is required to meet the challenges presented by the changing demographics of 21st century society.

2.5 The current state of the science in multimorbidity research

The remainder of the chapter will be dedicated to outlining the current state of the science in relation to multimorbidity, with a particular focus on research published in the last five years. The volume of research published on multimorbidity has been steadily increasing since the mid-2000s, and while it has been historically difficult to identify research published on multimorbidity due to heterogeneous terminology, the introduction of a separate medical subject heading (MeSH) term for multimorbidity in 2018 should improve how research in this area is indexed in future (Ahmed et al., 2020; Tugwell and Knottnerus, 2019).

2.5.1 Prevalence

Measuring the prevalence of multimorbidity is challenging. In a systematic review of prevalence studies, Fortin et al. (2012) found significant variation; for example in primary care the prevalence ranged from 3.5% to 98.5% in persons aged 75 or older. The reasons for this variation are multiple, and include different approaches to sampling, measurement, and the number of conditions which were included. Fortin et al. (2012) make the following recommendations to ensure a more uniform methodology in measuring multimorbidity:

- In primary care, random or whole-population samples can provide a representation of the overall situation. Sampling only those seen by the clinician can provide a representation of clinical workload. The approach should be determined by the research question.

- In the general population, random sampling at national level or particular geographic locations are appropriate.

- Data are often collected from either health records (potentially incomplete) or questionnaires (potentially biased). Multisource data collection is preferable where possible.

- Reporting should be both aggregated and disaggregated by sex. Accurate age group data is required, as opposed to broad variables (e.g., older/younger than 65).

- The number of conditions which are considered should be a minimum of 12 to avoid under-reporting. Data should be reported at both the level of those with two or more conditions, and those with three or more conditions.

This final point is particularly relevant given the heterogeneity with which multimorbidity is defined and measured. In a systematic review of systematic reviews, Johnston et al. (2019) encountered a range of definitions comprising various combinations of conditions and measures. Both Fortin et al. (2012) and Johnston et al. (2019) emphasise that researchers must be clear about how they define and measure multimorbidity, in order to improve the quality and transferability of research in the field.

A large epidemiology of multimorbidity was conducted in Scotland which meets most of the recommendations made by Fortin et al. (2012). In a cross-sectional sample of 1,751,841 people registered with primary care practices in Scotland, Barnett et al. (2012) used routinely-collected clinical data to identify the prevalence of 40 chronic conditions and multimorbidity. The authors estimated the prevalence of multimorbidity at 23.2% (95% CI: 23.1-23.2) of the population, with a greater proportion of women (26.2%, 95% CI: 26.1-26.3) than men (20.1%, 95% CI: 20.0-20.1) affected. As with the systematic review by Fortin et al. (2012), a strong association was noted between advancing age and the prevalence of multimorbidity, although Barnett et al. (2012) observe that the absolute number of people with multimorbidity who are under 65 is greater than the number who are older than 65 (210,500 vs 194,966). It was also noted that younger and middle-aged adults in the most socioeconomically deprived areas experienced multimorbidity between 10-15 years earlier than their counterparts in the most affluent areas. An interpretation of this would be to say that while multimorbidity is strongly associated with advancing age, simply conflating the two concepts risks missing a significant proportion of those living with multiple chronic conditions, in a way that is particularly harmful to those in lower socioeconomic strata.

A major contribution made by the Barnett et al. (2012) study was that it helped reconceptualise multimorbidity as the norm for people with chronic disease, even though health service design implicitly assumes the opposite. In another large retrospective study of 403,985 primary care registered adults in England, Cassell et al. (2018) detected a comparable prevalence of multimorbidity (27.2%, 95% CI: 27.1-27.3) using a framework of 36 chronic conditions. They also found a higher prevalence in women (30.0%, 95% CI: 29.8-30.2) than men (24.4%, 95% CI: 24.2-24.5), and noted that those in the most socioeconomically deprived quintile experienced greater incidence of multimorbidity than those in the least deprived quintile (30.0% vs 25.8%). The association between multimorbidity and healthcare use was also examined, the authors finding that despite only comprising just over a quarter of the population, people with multimorbidity accounted for 52.86% of primary care consultations, 78.7% of prescriptions, and 56.14% of hospital admissions (Cassell et al., 2018).

The situation in UK primary care resembles that described in other countries. In a systematic review of 39 studies with a combined total of 70,057,611 patients (heterogeneity prevented pooling of estimates), Violan et al. (2014) highlighted how advanced age and lower socioeconomic status were associated with multimorbidity in all included studies. Notably, all of the included studies were from Europe, North America, and Australia – there were no findings from low or middle-income countries.

The epidemiology of multimorbidity in community settings provides a more global perspective. In a systematic review and meta-analysis of 70 community-based observational studies (conducted in 49 countries, 31 of which are low or middle-income countries), Nguyen et al. (2019a) produced a pooled estimate of prevalence at 33.1% (95% CI: 30.0–36.3). It was also noted that people in high-income countries had significantly higher rates of multimorbidity than those in low or middle-income countries (37.9% vs 29.7%). It is possible that this reflects the relative paucity of multimorbidity research conducted in low or middle-income countries (Xu et al., 2017), however. Low and middle-income countries bear the vast majority of the global burden of chronic disease (Abebe et al., 2020), and the likelihood of premature death due to chronic disease is markedly higher for people in low-income countries than those in high-income countries (Bennett et al., 2020).

The epidemiology of multimorbidity in inpatient settings is less well-researched. A recent study of 41,545 inpatient from Scotland found that 27% (n=11,389) of patients had two or more conditions from a list of 30 (Robertson et al., 2022). In a larger study of inpatients from England (n=8,440,133) 31.6% (n=2,682,231) had two or more conditions from a list of 28 (Stokes et al., 2021).

2.5.2 Clusters and patterns of multimorbidity

In 2020 the UK Chief Medical Officer and Chief Scientific Officer for England, and the chair of the Medical Research Council (MRC) called for researchers to focus on mapping clusters of chronic disease in order to help advance multimorbidity research (Whitty and Watt, 2020). Seeking out latent relationships between conditions has been the subject of wealth of research since then, using a range of statistical approaches including exploratory factor analysis, latent class analysis, cluster analysis of diseases or people (Busija et al., 2019), and network analysis (Jones et al., 2023). Advances in machine learning methods and the ability of such models to handle large amounts of unstructured data are further extending the range of methodological tools available to researchers who aim to explore disease clusters (Hassaine et al., 2020).

Some studies have sought simply to identify latent clusters, while others have assessed the relationship between these clusters and a range of outcomes. Examples of the former range from Alshakhs et al. (2022)'s exploration of over 70 million US patients' records, to smaller studies conducted in a range of settings and with a variety of populations including hospital inpatients in Scotland (Robertson et al., 2022), city-dwelling adults in the Amazon region of Brazil (Araujo et al., 2018), or community-dwelling older adults in rural India (Kshatri et al., 2020). While variation does exist between these diverse studies, there appear to be some replicable clusters of multimorbidity between studies, particularly clusters of cardiometabolic conditions and clusters of mental health conditions (Busija et al., 2019).

Relationships between disease clusters and a range of outcomes have been investigated. Several studies identified significant relationships between mortality and specific clusters, including substance/alcohol misuse (Zhu et al., 2020), cardiorespiratory-metabolic multimorbidity (He et al., 2021), and cardiometabolic multimorbidity (Fan et al., 2022). Certain clusters were associated with death from coronavirus disease (COVID-19), including mental, neurological and cardiovascular multimorbidity (Bucholc et al., 2022), while other clusters were associated with severe disease during the early stages of the pandemic (Chudasama et al., 2021). Other studies failed to detect any significant relationships between specific clusters and mortality, despite nonspecific multimorbidity being significantly associated with death (Siah et al., 2022). A variety of statistical techniques have also been deployed to establish significant relationships between different disease clusters and increased healthcare use (Zhu et al., 2020), frailty (Nguyen et al., 2019b), polypharmacy (Menditto et al., 2019), worsening quality of life (Aoki et al., 2021), and depressive symptoms (Aoki et al., 2020), amongst others.

These findings are heterogeneous, but they do suggest that relationships between different multimorbidity clusters and certain outcomes exist, even if these are not necessarily transferrable from one context to another. In other cases, latent clusters may exist and may be linked to outcomes, but the utility of this information may be limited. To explore the feasibility of targeting interventions to reduce costs, Stokes et al. (2021) identified several clusters of multimorbidity; however, the number of patients associated with the highest-expenditure clusters were too small to make any useful reduction in service costs possible.

2.5.3 Polypharmacy

Polypharmacy is the term used to describe being prescribed multiple medications. In a cohort of hospitalised older adults (n=46,799, 91.07% of whom had multimorbidity), 56.32% also experienced polypharmacy, defined as five or more oral medications (Zhao et al., 2023). In a community-dwelling cohort in Belgium over a fifteen-year period, the rates of polypharmacy increased across all age groups except the youngest (0-25 years) (van den Akker et al., 2019). There are also age and sex-based differences in the way populations experience polypharmacy, although it can broadly be described as increasing in most demographics (Maxwell et al., 2021). In the context of multimorbidity, polypharmacy and potentially inappropriate prescribing is significantly associated with poor medication adherence (Liu et al., 2023). Recent research from Denmark and Switzerland indicates that most older adults with multimorbidity feel that they are prescribed too many medications, and would be comfortable with their General Practitioner (GP) deprescribing some of these if safe and appropriate to do so (Rozsnyai et al., 2020; Schiøtz et al., 2018).

The majority of research related to multimorbidity and polypharmacy seeks to address polypharmacy (Ali et al., 2022) by either optimising prescribing practices (Lun et al., 2021) or reducing inappropriate prescribing (Lee et al., 2020). In a review of systematic reviews, Ali et al. (2022) found that interventions were effective in reducing inappropriate prescribing and improving medication adherence, but that they did not generally improve other clinical outcomes. A scoping review by Lee et al. (2020) provides an overview of the components which typically constitute an intervention to address inappropriate prescribing for older adults with multimorbidity. Of the 80 complex interventions reviewed, the majority (70%) involved medication reviews, and most of these (70%) were led by pharmacists. Other components included staff training (26.3%) and the use of screening criteria and checklists to guide deprescribing decisions (22.5%) (Lee et al., 2020).

2.5.4 Interventions

Aside from those which specifically address polypharmacy, interventions for people with multimorbidity are also a significant feature of current research. Nursing interventions are the focus of the first phase of the thesis (see Chapter 5); therefore, this section will discuss interventions more generally.

In a Cochrane systematic review of interventions to improve outcomes for people with multimorbidity in primary care and community settings, Smith et al. (2021) noted that most interventions either aimed to reorganise care through case management or multidisciplinary team work, or were patient-oriented interventions which focussed on self-management. As was the case with the polypharmacy interventions discussed in the preceding section, there was little evidence of improved clinical outcomes. There was strong evidence to suggest interventions improved mental health and reduced depressive symptoms, although some studies adopted a comorbidity framework which assumed comorbid depression, which may limit how transferrable these findings are to a population with general multimorbidity. There was little evidence of reduced healthcare usage (Smith et al., 2021).

By definition, interventions which aim to improve outcomes in people with multimorbidity are heterogenous (Fortin et al., 2022); for example, from a list of ten conditions there are more than 1,000 possible combinations of two or more conditions an individual can have. Therefore, multimorbidity interventions tend to target other areas of care rather than disease-specific outcomes. Self-management is one such area; in a scoping review of behaviour change interventions to improve self-management, Jager et al. (2023) describe a variety of approaches including cognitive behavioural therapy, counselling, mindfulness therapy and motivational interviewing. Similar to the findings of Smith et al. (2021), the main improvements were noted in relation to depressive symptoms, and again the majority of studies are best described as applying a comorbidity framework rather than focussing on multimorbidity (Jager et al., 2023).

In a recent randomised controlled trial (RCT), Khunti et al. (2021) assessed the effectiveness of a self-management intervention in improving physical activity in a population of people with multimorbidity. Unlike many of the studies included in the reviews by Smith et al. (2021) and Jager et al. (2023), Khunti and colleagues employed a multimorbidity framework, sampling a population with two or more chronic conditions from a possible 40 conditions. Despite this, the intervention failed to generate any significant change in physical activity compared to the control group. Another cluster RCT of a primary care-based intervention involving people with multimorbidity (defined as three or more conditions) failed to demonstrate either improvements in quality of life (Salisbury et al., 2018) or economic viability (Thorn et al., 2020).

Reflecting on the frequency with which multimorbidity interventions fail to evidence significant improvements in outcomes in RCTs, Fortin et al. (2022) suggest that RCTs may not be the most appropriate design for evaluating such interventions, and that detecting improvements may be better facilitated through qualitative evaluation or quasi-experimental designs with repeated measures of outcomes. A core outcome set for evaluating multimorbidity interventions exists (Smith et al., 2018), yet the benefits of these interventions may fall outside what is measured by these outcomes (Fortin et al., 2022).

2.5.5 COVID-19

The onset of the COVID-19 pandemic caused society to change its behaviours in part to protect people with chronic conditions who were particularly susceptible to the virus. However, public health messaging focussed almost exclusively on individual conditions and there was a paucity of research which sought to understand how people with multimorbidity would be affected (Mair et al., 2020). As the pandemic progressed, researchers began to address the knowledge gap.

A cross-sectional study of patients in Italy during the early stages of the pandemic (when northern Italy was one of the most affected regions in the world) identified that multimorbidity (determined using the Charlson Comorbidity Index) was significantly associated with mortality in people with COVID-19 (Iaccarino et al., 2020). The effects on accessing care were also described in a study from India, which found people with multimorbidity during lockdown were significantly more affected than others by barriers to physician consultation, diagnostic services, travelling to healthcare services and restricted mobility (Pati et al., 2020). In Brazil there were efforts to map the number of people over 50 with multimorbidity who were vulnerable to COVID-19, finding that 52% of the study population (n=9,412) had two or more conditions which increased their risk of severe COVID-19 disease (Nunes et al., 2020).

In Scotland, Agrawal et al. (2022) examined a cohort of people admitted to hospital with COVID-19 during the first wave of the pandemic (February to September 2020), finding that 57.9% of the 4,684 patients for whom data linkage was possible had two or more chronic conditions. Adjusting for age, sex, and deprivation, multimorbidity was significantly associated with mortality compared to those with fewer than two conditions (adjusted odds ratio (aOR): 1.48, 95% CI: 1.26–1.75, $p<0.001$).

A pivotal point in the pandemic was the rapid research and deployment of several whole virus, protein-based, viral vector, and nucleic acid (mRNA) vaccinations, at a speed which was previously unimaginable (Ndwandwe and Wiysonge, 2021). However, the speed at which vaccinations were developed was a contributing factor in a wave of vaccine hesitancy which emerged, particularly in low and middle income countries (Machingaidze and Wiysonge, 2021), where the risk of chronic disease-related mortality is high (Bennett et al., 2020). COVID-19 vaccinations and boosters have been shown to be effective in reducing mortality in people with multimorbidity (Lai et al., 2023) without any increased risk of adverse events (Lai et al., 2022), however, inequitable distribution of vaccines and increased access to online disinformation mean that there is still a risk of vaccine hesitancy impacting on uptake, particularly in low and middle income countries (Machingaidze and Wiysonge, 2021).

The effects of the COVID-19 pandemic on multimorbidity and multimorbidity research are ongoing. A one-year longitudinal cohort study of 97 older adults with multimorbidity found that during the pandemic, participants exhibited reduced functional capacity and worsening cognitive state (Ruzafa-Martinez et al., 2023). However, the small sample size, convenience sampling, and the possibility that the changes do not result from the exposure limit the generalisability of these findings. Less equivocal is the impact of the pandemic on multimorbidity research, with some studies being disrupted in order to adhere to pandemic restrictions and to protect capacity for COVID-19 related activities (Zamorano et al., 2022).

2.5.6 Treatment burden

Treatment burden is the term used to describe the daily work undertaken by patients and their relational networks in order to adhere to treatment regimens. Burden of Treatment Theory (May et al., 2014) is discussed in depth in the next chapter; this section is concerned simply with the work of patienthood itself and how this has been explored in recent research related to multimorbidity.

Treatment burden is a core outcome in multimorbidity research (Smith et al., 2018), and a validated tool has been developed in order to measure its effects: the Multimorbidity Treatment Burden Questionnaire (Duncan et al., 2018). The questions in the questionnaire are outlined in Table 2-1; users can select a response with an associated score, ranging from ‘extremely difficult’ (5 points) to ‘not difficult’ (1 point), or select ‘does not apply’ (0 points). A scoring system is available which allows the person administering the questionnaire to assign a level of burden ranging from ‘no burden’ to ‘high burden’. In the original validation study, questions three, nine and ten were excluded but may be considered optional in other populations (Duncan et al., 2018).

Please tell us how much difficulty you have with the following:
1. Taking lots of medications
2. Remembering how and when to take medication
3. Paying for prescriptions, over the counter medication or equipment
4. Collecting prescription medication
5. Monitoring your medical conditions (e.g. checking your blood pressure or blood sugar, monitoring your symptoms etc.)
6. Arranging appointments with health professionals
7. Seeing lots of different health professionals
8. Attending appointments with health professionals (e.g. getting time off work, arranging transport etc.)
9. Getting health care in the evenings and at weekends
10. Getting help from community services (e.g. physiotherapy, district nurses etc.)
11. Obtaining clear and up-to-date information about your condition
12. Making recommended lifestyle changes (e.g. diet and exercise etc.)
13. Having to rely on help from family and friends

Table 2-1: Questions from the Multimorbidity Treatment Burden Questionnaire (Duncan et al, 2018).

The questionnaire is useful in highlighting the breadth of tasks which comprise treatment burden. In a concept analysis, Sav et al. (2015) characterised treatment burden as a dynamic, multidimensional concept which comprises objective and subjective elements. When the perceived difficulty of healthcare tasks exceeds tolerable parameters, people with multimorbidity experience worse physical and mental health, and perceive the quality of chronic illness care to be poorer (Boyd et al., 2014), while people who experience less burdensome care are more likely to rate it positively (Hu et al., 2022).

In a survey of primary care patients (n=835) aged 50 or older with three or more conditions (Morris et al., 2021), participants completed the Multimorbidity Treatment Burden Questionnaire alongside a single-item measure of treatment burden. In multivariable adjusted analyses, significant associations were noted between self-reported high levels of burden and poor health literacy, financial difficulty, higher number of chronic conditions (reaching significance at five or more conditions) and increasing polypharmacy. The single-item measure had high negative predictive value but was less effective in detecting high treatment burden (Morris et al., 2021). In a qualitative study in low-income rural Australia, healthcare staff were aware of the concept of treatment burden (if not the phrase itself), and identified poor healthcare literacy, financial troubles, and poor mental health as having a deleterious effect on capacity to undertake work (Hardman et al., 2021).

There are several other measures which can be used to assess treatment burden in multimorbidity beyond the Multimorbidity Treatment Burden Questionnaire. However, as is the case with many aspects of multimorbidity research, there is limited evaluation of these measures in low and middle-income countries, which raises doubts about the suitability of tools developed in nations with better access to education and long term health care (Mendoza-Quispe et al., 2023).

Another area of contemporary research surrounding treatment burden and multimorbidity is the advancement and development of new theory to support and extend existing models. One example of this is a qualitative study from South Africa (van Pinxteren et al., 2023), which developed the concept of persistent precarity in the context of treatment burden. The authors describe how precarity is not just financial, but extends to shelter, geography, the threat of violence and insufficient support from health services. This precarity disrupts the balance between the workload and capacity to undertake the work of patienthood (van Pinxteren et al., 2023).

2.5.7 Palliative and end of life care

In a mixed methods study in Scotland, it was estimated that in 2017, 27.2% of deaths were people with two or more conditions from disease groups associated with palliative care needs, such as cancer, organ failure, dementia, neurological conditions such as stroke, or HIV. By 2040, this number is projected to be around 43.5% (Finucane et al., 2021). This projection is based on people with conditions in two distinct groups, therefore it does not include people with two types of cancer, multiple organ failure, or stroke and multiple sclerosis, for example. It also does not include people with multimorbidity who only have one condition associated with palliative care needs, even though these individuals will nonetheless have both multimorbidity and palliative care needs. This means that the projections likely underestimate the true proportion of deaths which will be people with multimorbidity and palliative care needs.

Given the above, it is clear that much as multimorbidity is the norm for people with chronic conditions (Whitty and Watt, 2020), it is also the norm for people with palliative conditions. It is important then to understand what needs this group have in relation to palliative and end-of-life care. In a scoping review of studies involving adults aged 60 and over with two or more conditions in the last two years of life, Nicholson et al. (2023) found that physical needs (including pain, function, respiratory and gastrointestinal needs, and cognitive needs) were most commonly identified, however, other dimensions (practical, psychological, social and spiritual needs) were often not measured by the tools used in the studies. Non-physical needs were more frequently referenced in qualitative studies; the authors provide several hypotheses to account for this disparity, the most plausible of which is that quality of care is often measured from the perspective of the service, and that the needs of older people with palliative conditions and multimorbidity are often non-physical (Nicholson et al., 2023).

There is also a need to ensure that people with multimorbidity and palliative conditions are provided with adequate information to make decisions about end-of-life care. In a systematic review of studies involving this patient group, Gonzalez-Gonzalez et al. (2021) found disparity between preferences in relation to place of death and life-sustaining treatments, and also between preferences dependant on whether the decision was real or a hypothetical one. The authors conclude that information about treatment burden, outcomes and potential adverse outcomes from treatment must be provided to facilitate decisions.

In a large review of death certificates in one US state over a five-year period (n=303,710), Wagner et al. (2019) compared levels of healthcare utilisation in the last 30 days of life for people who had one, two or three or more conditions associated with palliative care needs. As with the study by Finucane et al. (2021), this analysis did not include people who had multimorbidity comprised of a mixture of palliative and non-palliative conditions. In a comparison between people with three or more conditions versus two versus one, it was found that more conditions were significantly ($p<0.001$) associated with increased inpatient admissions (37% vs 28% vs 19%), ED attendance (5% vs 4% vs 2%), and intensive care unit (ICU) admission (28% vs 20% vs 12%) (Wagner et al., 2019).

What this reveals is that multimorbidity is common in people with palliative conditions, that it drives healthcare utilisation in this group, that needs are multidimensional and not solely physical, and that decisions about care must be made in the context of adequate information which is relevant to people with multiple chronic conditions.

2.5.8 Nursing

The paucity of research which explores the role of nursing in relation to multimorbidity was a driving factor in the direction taken by this thesis. Much of the research surrounds specific interventions, which will be dealt with later in the thesis (Chapter 5).

In a qualitative study of UK nurses from a variety of professional backgrounds, the issues of how multimorbidity will affect future nursing practice and how the profession should adapt to meet the challenge of multimorbidity were discussed (O'Connor et al., 2018). Several priorities were identified, including helping people cope with treatment burden, redesigning health services to better meet the needs of people with multiple conditions, prioritising holistic and person-centred care, developing an evidence base for multimorbidity nursing, and stimulating learning about strategies to care for people with multimorbidity. The authors conclude that there is a lack of models and theories used in contemporary nursing which specifically address multimorbidity (O'Connor et al., 2018).

The themes identified by O'Connor et al. (2018) are similar to those identified in a systematic review of qualitative studies related to nurses’ perceptions of caring for adults with multimorbidity by Whitehead et al. (2022). The authors found that nurses recognise the challenge multimorbidity presents to existing models of chronic illness care, and that multimorbidity nursing requires holistic and person-centred planning and implementation of care. Fostering therapeutic relationships was viewed as central to the role of nurses in the age of multimorbidity; however, it was also emphasised that caring for people with multimorbidity is a multidisciplinary endeavour, one which requires collaboration between teams and managing conflicting advice (Whitehead et al., 2022). These findings were further advanced in a qualitative study of nurses in

Australia (Whitehead et al., 2023), which recognised the evolving role nurses have to play in caring for people with multimorbidity as part of a collaborative effort, and emphasised the needs for education and training to support this effort.

In a qualitative study conducted in Pakistan, Younas and Inayat (2023) explore this role in more detail, focussing specifically on how nurses are involved in alleviating suffering in this patient group. The authors highlighted how nurses conducted in-depth exploration of the patients' health/illness situation and perceived complexity, and prioritised psychosocial and emotional needs. They also were involved in the creation of safe environments in which patients could express their needs, and proactively sought to instil hope and encouragement in spite of the complexity and frustration which may accompany living with multimorbidity (Younas and Inayat, 2023).

In summary, the nursing profession recognises the challenge presented by multimorbidity; however, there is a lack of research and guidance to support nurses in adapting to meet this challenge. Nurses and the nursing profession have a role in shaping the way care is provided to the growing number of people living with multiple chronic conditions, as part of a multidisciplinary effort.

2.6 Where this thesis fits within the literature

This thesis aims to address the gaps in what is known about multimorbidity and nursing. It is important to emphasise what these gaps are then, before moving on to the rest of the thesis. In essence, the thesis aims to address the lack of clarity around what contribution nursing can make in caring for people with multimorbidity and palliative conditions.

So far in this chapter, it has been acknowledged that multiple perspectives on diseases have existed throughout history and persist into contemporary clinical practice. The current demographics of society require a shift from single condition or comorbidity frameworks to a multimorbidity framework which views conditions as dynamic, overlapping and existing within the context of the person. Nursing care has developed throughout history and despite becoming increasingly biomedical, remains primarily concerned with the therapeutic act of providing care. In the context of multidisciplinary care, nursing has a role to play in meeting the challenges of multimorbidity.

Considering more contemporary research; there has been a move in recent years towards trying to understand latent clusters of conditions and how these affect outcomes. There are a range of interventions which have been developed to improve care and outcomes for people with multimorbidity, targeting issues such as polypharmacy or burdensome treatment regimens. The COVID-19 pandemic delayed research in this area, and people with multimorbidity were particularly vulnerable to the virus. Multimorbidity is the norm in people with palliative conditions, and this proportion is predicted to grow significantly in the near future. Despite this, relatively little is known about how nurses can help improve care for people with multimorbidity.

2.7 Chapter summary

This chapter has provided the historical and contemporary context for the remainder of the thesis. In doing this, the lack of clarity around the role of nursing in relation to multimorbidity has been highlighted. It is this gap which will be addressed by the research described in the following chapters. The next chapter outlines the theoretical framework for the thesis and reviews the literature pertaining to the methods employed.

Chapter 3. Literature and theory pertaining to the methods

3.1 Introduction

The aim of this chapter is to provide the necessary background context to the methods employed in this thesis, and to explain why these methods were adopted. Chapter 4 will provide a more straightforward account of the methods used in each phase of the research.

The chapter opens with an overview of how theory is understood in the context of nursing and health care research before outlining the broad paradigms which shape the way reality is conceptualised and knowledge is acquired. Justification is provided for why this research has been conducted from a critical realist perspective. A similar overview of the quantitative and qualitative traditions in science follow, alongside a justification for why this thesis employs a combination of both approaches, namely mixed methods. Specific issues in relation to both approaches (as employed in this thesis) are addressed, before the chapter closes on a description of how the concepts described thus far are positioned within the theoretical framework which underpins the thesis.

3.2 Theoretical thinking in nursing science

Before moving into any in-depth discussion on theory and theoretical concepts, it is important to first define what is meant by theory, what types of theory will be discussed, and how different theories contribute to nursing science. A simple framework is provided by Higgins and Moore (2000), in which theory is stratified into four overlapping levels: meta-theory, grand theory, middle-range theory, and micro-range theory. Figure 3-1 provides an example of how these different levels of theoretical thinking are arranged, with references to some of the theoretical concepts which will be discussed in this chapter and throughout the thesis.

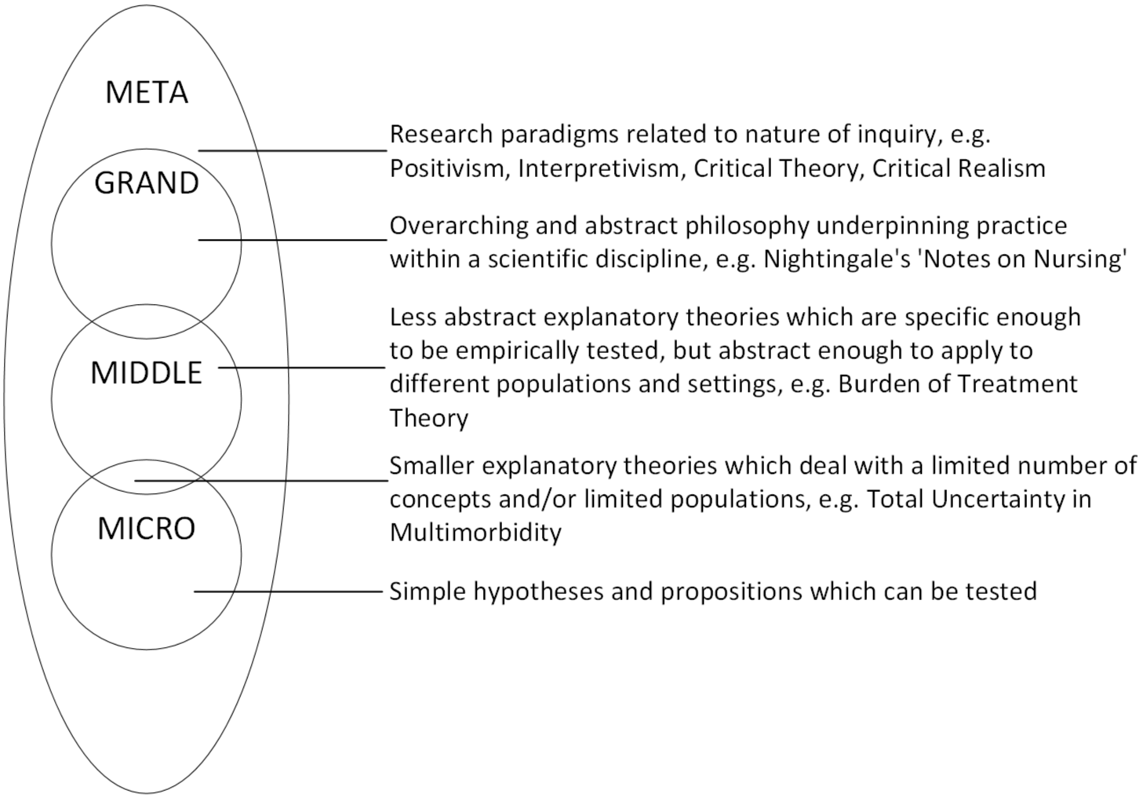


Figure 3-1: Levels of theoretical thinking in nursing. Adapted from Higgins & Moore (2000).

Meta-theories are in effect overarching theories where the subject of interest are grand, middle, and micro-range theories; they are concerned with the nature of enquiry and knowledge acquisition (Edwards, 2014). Grand theories are abstract theories which determine the parameters of practice and enquiry within a scientific discipline; Higgins and Moore (2000) use the example of Florence Nightingale’s ‘Notes on Nursing’ (1860) as the first such grand theory of nursing science. Middle-range theories constitute the majority of nursing theory developed over the last 20-30 years; they are broad enough to apply to different populations and settings but differ from grand theory in that they are less abstract and can be tested empirically (Risjord, 2011). Micro-range theories overlap with middle-range theory and differ from such theory in that they tend to deal with limited populations. More readily distinguishable from middle-range theories are the micro-theories which are simple hypotheses and propositions which can be tested empirically (Higgins and Moore, 2000). A common criticism of nursing science is its tendency to deal mostly with middle and micro-range theory, with little attention to grand theory (Florczak et al., 2012; Risjord, 2011). However, as indicated earlier it is challenging to empirically assess the application of grand theories due to their level of abstraction (Higgins and Moore, 2000); therefore, this thesis is concerned primarily with middle and micro-range theories, framed within the meta-theoretical paradigm of critical realism.

3.3 Meta-theory (or paradigms in research)

In science and research, the concept of ‘paradigms’ and the transition from one to another (paradigm-shifts) can be traced back to Thomas Kuhn’s *The Structure of Scientific Revolutions,* first published in 1962 (Kuhn, 2012). Paradigms have come to represent schools of thought, with shared practices and beliefs regarding the nature of reality (ontology), the means through which knowledge is acquired (epistemology), and the processes through which scientific understanding can be achieved (methodology). See Figure 3-2 for a summary of these concepts. There is also the matter of methods, which are the practical tools used by researchers to collect and analyse data (as opposed to the overarching methodology).

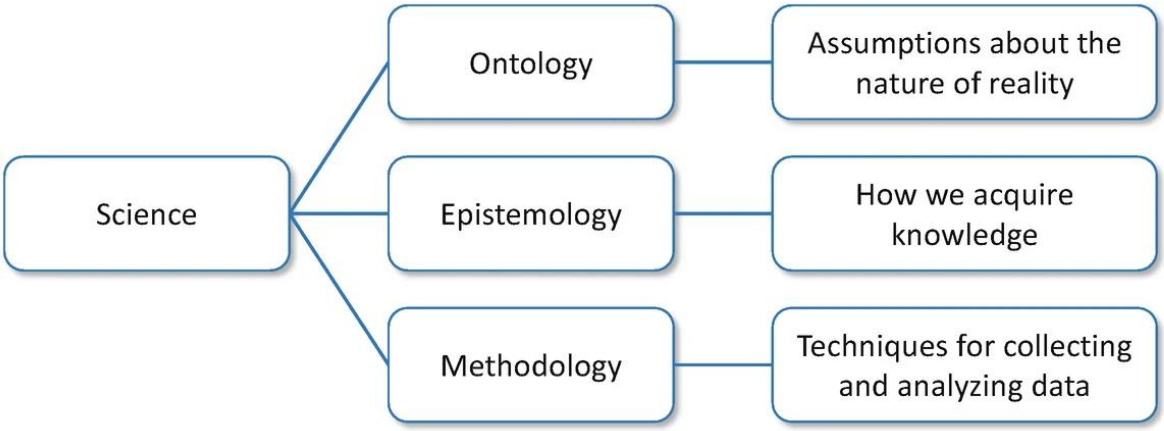


Figure 3-2: **Ontology, epistemology and methodology. From Sallis et al (2021).**

In nursing and healthcare research, most approaches can be ascribed to one of three major research paradigms: positivism, interpretivism, and critical theory (Ryan, 2018; Weaver and Olson, 2006). However, many intervening traditions and subcategories within these paradigms exist (Willis, 2007), and the approach adopted in this thesis - critical realism – is increasingly used in healthcare research. In this section a summary of these four paradigms is provided, alongside a justification for why critical realism was selected as the most appropriate approach.

3.3.1 Positivism (and post-positivism)

The roots of positivism can be traced from the middle-ages through the Renaissance, the Enlightenment, and into contemporary scientific practice; it emerged as a response to the proliferation of metaphysical explanations for the way the world works and how humans interact with it (Willis, 2007). At its heart, positivism assumes an ontological realism which can be objectively understood by epistemic activity, most commonly through experimentation (Ryan, 2018). In practical terms, this means that there is only one reality, and that by conducting experiments and controlling for variables which may affect the results of the experiment, humans can arrive at an objective understanding of how the world works.

The methodology most commonly associated with the positivist tradition is quantitative, relying on statistical tests and observation, and the necessary reduction of what can be known to objective statements grounded in mathematical or logical proofs (Outhwaite, 2015). The methods, as mentioned previously, are often experimental, the gold-standard of these being the randomised controlled trial.

In contemporary science, there is a strong argument to be made that randomised controlled trials and similar methods are often misattributed to the positivist paradigm, and that they tend more towards what is classified as *post*-positivism (Corry et al., 2019). Karl Popper (in what may be considered a Kuhnian paradigm-shift) challenged the deductive reasoning employed by the positivist tradition in the early-to-mid 20th century, arguing for a hypothetico-deductive approach which emphasised falsification of tentative hypotheses over verification of observed theories (Popper, 1959). Revisiting the example attributed to Scottish Enlightenment philosopher David Hulme, he argued that it was not possible to verify that all swans are white through observation of white swans, but that observing a single black swan was sufficient to falsify this theory (Outhwaite, 2015). Thus, the emphasis shifts from confirmation of hypotheses through observation, to the generation of tentative hypotheses which are susceptible to being proven wrong or falsified through experimentation.

Experimentation and randomised controlled trials in nursing and healthcare allow for the fallibility of scientific knowledge (by being open to falsification of hypotheses), and acknowledge the potential influence of the scientist on the results (the necessity for double-blind trials being one example) (Corry et al., 2019). Yet the decision to reject the positivist or post-positivist paradigm in this project was underpinned by one overarching inadequacy in the meta-theory. Positivistic science seeks to isolate events from the social and natural world, it assumes a realist ontology which is accessible to human understanding, and applies laws drawn from these isolated observations to a world which remains influenced by seen and unseen social and naturalistic variables. Responding to these assumptions, Roy Bhaskar argues:

> …that knowledge is a social product, produced by means of antecedent social products; but that the objects of which, in the social activity of science, knowledge comes to be produced, exist and act quite independently of men. (Bhaskar, 2013, pp. 16-17)

This is not to dispense with the positivist tradition entirely, most importantly not the concept of a realist ontology. However, in the context of this thesis, there remains a need to ground knowledge in the social and naturalistic world in which the research is conducted.

3.3.2 Interpretivism

While the lineage of contemporary positivistic research can be traced back to the middle ages, the philosophical traditions of the interpretivist paradigm have their roots in the classical philosophy of ancient Greece and Rome (Willis, 2007). However, it is the work of Immanuel Kant (most notably his 1781 work, *Critique of Pure Reason* (Kant, 1908)) which provides the foundations on which the interpretivist philosophy of science is based. Kant argues that the acquisition of knowledge goes beyond empirical observation but is achieved through human interpretation of these observations. As such, the researcher as interpreter plays a more significant role, and the realities constructed by the research act are many and varied (Ormston et al., 2013).

In distinguishing positivism from interpretivism, this ontological difference is perhaps the most significant. While positivism holds that there is a single objective reality, interpretivism is relativistic in its ontology, assuming that there is no such single shared reality (Ryan, 2018). The epistemological position of interpretivism (and the closely related meta-theory of constructivism) is also necessarily different to that of positivism. While positivism seeks to employ the deductive processes of the natural sciences to the social world in order to generate value-neutral generalisations about reality, interpretivists construct or interpret knowledge inductively and often through a theoretical lens. Given this, the methodologies which are most commonly associated with the interpretivist paradigm are qualitative, including phenomenology, ethnography, and grounded theory, amongst others (Ormston et al., 2013). The methods employed by those who adopt an interpretivist approach include in-depth interviews, focus groups and textual analysis (Lewis and McNaughton Nicholls, 2013).

For the purpose of this thesis, the embedding of the interpretivist paradigm in the social world and its acknowledgement of the impact of the researcher on the research are desirable characteristics. However, the relativistic nature of the interpretivist ontology is fundamentally at odds with the aims of this thesis, particularly in relation to the quantitative phase of the research.

3.3.3 Critical theory

The emergence of critical theory comes significantly after the paradigms discussed in the preceding sections. In the early 19th century, scholars of the Frankfurt School (located in the city of its name) developed critical theory, applying variations on classical Marxist political theory to a range of subjects other than class conflict (Willis, 2007). In simple terms, critical theory employs a historically-informed realist ontology, and an epistemology which is subjective and modified by power structures such as race, class, politics and gender (Ryan, 2018). The methodology of critical theory can be described as critical and reconstructive, as outlined by Strydom:

> It is specifically designed to suggest, not simply the critical interpretation of meaning, but rather the critical, interpretative reconstruction of real mechanisms in the context of the development of social structures in socio-historical processes. (Strydom, 2011, p. 14)

Ignoring the historical and political dimensions of healthcare in an age of neoliberalism is neither possible nor prudent, but critical theory is not the only paradigm which allows theoretically-guided and critical nursing research (Nairn, 2019). Critical realism also provides a framework through which this can be achieved.

3.3.4 Critical realism

Locating critical realism in relation to the other paradigms can be challenging. For some, it overlaps with critical theory (Ryan, 2018), while for others it is a distinct philosophy of science which draws on elements of positivism and constructivism (Lawani, 2021). To place it in historical context, Bhaskar published *A Realist Theory of Science* in 1970, largely in response to the positivistic nature endemic to the science of that period. Central to Bhaskar's argument was what he described as the *epistemic fallacy*, or the reduction of statements about ontology (i.e., what is real) to statements about what can be observed (epistemological statements). In Bhaskar's words:

> Empirical realism is underpinned by a metaphysical dogma, which I call the epistemic fallacy, that statements about being can always be transposed into statements about our knowledge of being. As ontology cannot, it is argued, be reduced to epistemology this mistake merely covers the generation of an implicit ontology based on the category of experience; and an implicit realism based on the presumed characteristics of the objects of experience… (Bhaskar, 2013, p. 16)

Critical realist ontology stratifies reality into three domains (Figure 3-3): the 'real', in which events are generated by structures and mechanisms which are inaccessible to human perception; the 'actual', in which events (both observed and unobserved) occur; and the 'empirical', in which perceptions, experiences and observations take place (Hoddy, 2019).

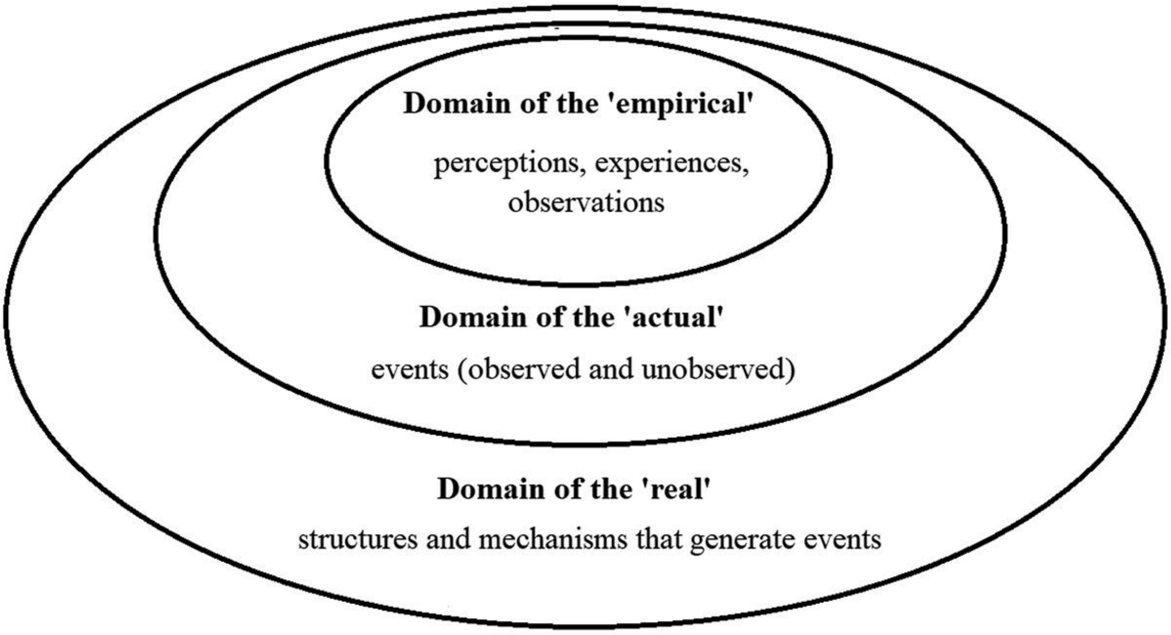


Figure 3-3: Critical realism's stratified reality. From Hoddy (2019).

The independence of the real world from the scientist’s knowledge of it is underpinned by the distinction between the ‘transitive’ and ‘intransitive’ domains of knowledge. Objects of study such as social processes and phenomena comprise the transitive domain, while the theories and discourses which are created to explain such phenomena are intransitive (Sayer, 2000). Critical realists acknowledge that changes in the intransitive domain (i.e., revised or replaced theories) do not result in corresponding transitive changes. As Sayer (2000, p. 11) explains, the world did not physically change shape when humans moved from a flat-earth to a round-earth theory.

Earlier in this chapter, the interpretivist paradigm was rejected on the grounds of its’ ontological relativism; the aims of this thesis involve the assumption of a shared reality, one on which generalisations can be made and causal inferences can be hypothesised. A critical realist ontology permits these assumptions, yet unlike the positivist paradigm it does not claim to perceive the ‘real’, rather it allows for inferences about causal mechanisms to be made based on observations of the empirical domain.

The epistemology of critical realism also allows for the recognition of the social and humanistic factors in the scientific process, and their effects on the conclusions drawn. Figure **3-4** shows the difference in the way critical realism conceives of causal mechanisms in comparison to the positivist understanding. In positivism, cause leads directly to the observed effect in a sequence of events and is assumed to do so in a regular (i.e., predictable) manner. In a critical realist ontology, other seen and unseen conditions (or mechanisms) intersect with the effect. Epistemic activity therefore is concerned with finding plausible explanations of how the observed effect occurs, recognising that the mechanisms and structures under investigation are not the sole actors responsible for the effect.

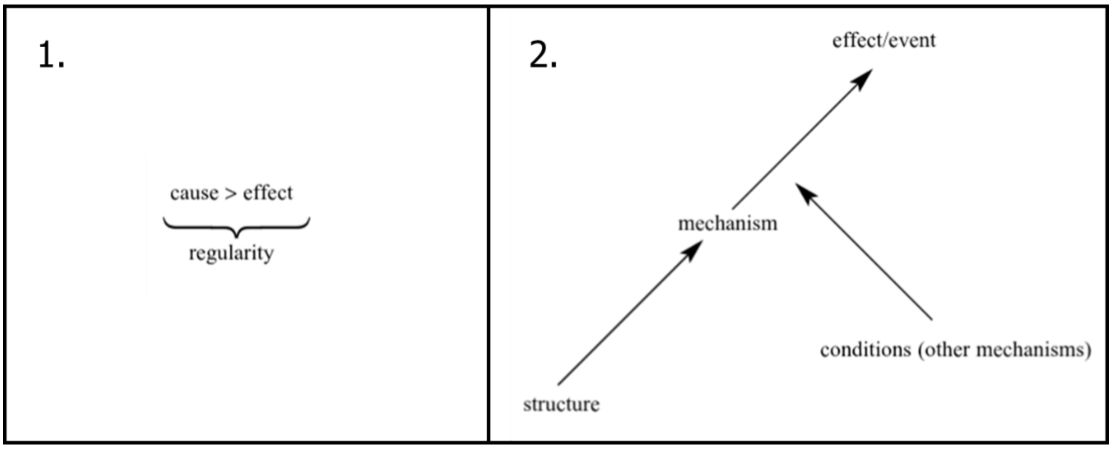


Figure 3-4: **Differences in causal mechanisms as understood by (1) positivism and (2) realism. Composite of images from Sayer (2000).**

To paraphrase, critical realist epistemology aims to describe the real world based on the experience of participants, and to make claims about the mechanisms which must exist for the observed events to have taken place (Lawani, 2021). Theories and conclusions borne of this process are grounded by the conditions which makes their observation possible, and as such multiple intransitive theories can co-exist and overlap, offering different perspectives on the same transitive problem. Bhaskar describes this ‘epistemological relativism’ as “the handmaiden of ontological realism” (2013, p. 249). As noted earlier, the ability to hold multiple perspectives is a necessary condition for the project outlined in this thesis, particularly in relation to the qualitative element where middle and micro-range theories are important to the analysis.

The final aspect of critical realism which requires explanation is how a complete philosophy of science reconciles ontological realism with epistemological relativism. This is especially pertinent given that this thesis aims to reconcile quantitative hypothetico-deductive conclusions with qualitative inductive methods in a coherent scientific argument. Methodologically, critical realism allows for diverse approaches in the creation of knowledge (Sayer, 2000), and decisions on the applicability of a theory and its’ suitability over others is ultimately based on how well it can account for the mechanisms responsible for an observed event. Bhaskar states the scientist must exercise ‘judgemental rationality’. In simple terms, this is the ability of a capable agent to ascribe preference to particular theories over others based upon their explanatory power (Bhaskar, 2009). This reasoning, which allows the scientist to build models and theories and to evaluate their suitability, is referred to as retroductive reasoning. This same rationality and retroduction allows for convergent approaches to the synthesis of knowledge generated by quantitative and qualitative methods, as is necessary in the conduct of the research described in this thesis.

3.3.5 Summary of paradigms discussed in this section

The ontic realism, epistemic relativism, and judgemental rationality of critical realism provide a framework through which the aims of this thesis can be achieved in a manner congruent with a comprehensive philosophy of science. Table 3-1 provides an overview of each of the four main paradigms discussed here, alongside a rationale for why they were either rejected or accepted.

	Positivism	Interpretivism	Critical theory	Critical realism
Ontology	Objective reality with constant conjunction of events	Multiple realities, can be socially-constructed	Objective and historically-informed	Objective but stratified, causal mechanisms can be inferred from observed events
Epistemology	Hypothetico-deductive, emphasis on production of laws and predictions	Observations are interpreted by individuals and groups	Subjective interpretation modified by application of theoretical (or historical) lens	Retroductive reasoning which seeks to explain the reasons for events. Relativistic- different theories can co-exist
Methodology	Generally quantitative	Generally qualitative	Can accommodate qualitative, quantitative and mixed methods	Can accommodate qualitative, quantitative and mixed methods
Methods	Experiments, controlled trials, statistical analysis	Interviews, focus groups, textual analysis	Not prescriptive	Not prescriptive
Reason for acceptance or rejection	Rejected primarily due to objective epistemic approach and naïve realism.	Rejected primarily due to relativist ontology, incompatible with statements about causation and generalisation.	Allows for critical analysis of various types of data through theoretical lens. Represents a range of disparate theoretical perspectives, none of which are suitable for the planned study.	Accepted due to realist ontology which allows for statements about causal mechanisms, and epistemic relativism, which allows for rationalisation of data collected and analysed using mixed methods. Allows application of a priori theoretical models to generate new theory.

Table 3-1: Summary of research paradigms

3.4 Middle range theory – Burden of Treatment Theory

The overarching philosophy of science (or meta-theory) provides the ontic and epistemic framework within which the thesis is to be conducted, as well as guiding towards a methodology which can be deployed to address the aims of the research. However, to move beyond simple description and to make theoretical contributions to a field requires that the research is both grounded in a priori theory and that it generates new theory. As described above by Higgins and Moore (2000), these smaller, less abstract explanatory theories which deal with discrete concepts are more commonly categorised as middle or micro-range theories. This section will outline Burden of Treatment Theory, described by May et al. (2014) as a structural model to understand the relationship between chronically unwell people, their relational networks, and healthcare services.

Burden of Treatment Theory satisfies the description of a middle-range theory in that it is sufficiently abstract to be applied across a range of settings and populations (Gallacher et al., 2022), but specific enough to be empirically testable, including with people with multimorbidity (Chikumbu et al., 2022).

3.4.1 Development of Burden of Treatment Theory

The development of theory is often framed as either an orderly process in which old theory begets new theory, or a more chaotic and dialectic process in which new theory rapidly emerges in opposition to that which currently prevails (Vagero, 2006). Both cases recognise, however, that theory has roots in other theories, and that tracing the lineage of a particular theory has no natural end point. Burden of Treatment Theory is no exception to this, yet it is important to highlight some of its antecedents in order to better understand what it is, and what it aims to explain.

The first of such theories highlighted by May et al. (2014) is Normalisation Process Theory (NPT) (May and Finch, 2009). NPT seeks to explain why things are (or are not) normalised into routine practice. To fully explain NPT would be beyond the scope of this thesis, but the salient point is that the four generative mechanisms of implementation (coherence, cognitive participation, collective action, and reflexive monitoring) are also present in Burden of Treatment

Theory. Research using NPT led to a recognition of patient workload (i.e., treatment burden) and the concept of 'minimally-disruptive medicine', which centres around the need to understand treatment burden, to encourage care coordination, to acknowledge comorbidity in clinical evidence, and to prioritise the patient perspective in healthcare (May et al., 2009).

May et al. (2014) also cite the Cumulative Complexity Model (Shippee et al., 2012) as providing a means of understanding the way that patient work is delegated to patients by healthcare providers, and how these burdens are balanced against patient capacity to undertake the work. The model is presented in Figure 3-5. Two key distinctions between the Cumulative Complexity Model and Burden of Treatment Theory should be acknowledged; firstly, the former proposes that the imbalance between workload and capacity drive patient complexity, and secondly, the Cumulative Complexity Model is a patient-level model, whereas Burden of Treatment Theory is a structural model which also encompasses health systems and describes mechanisms at more than one level (May et al., 2014).

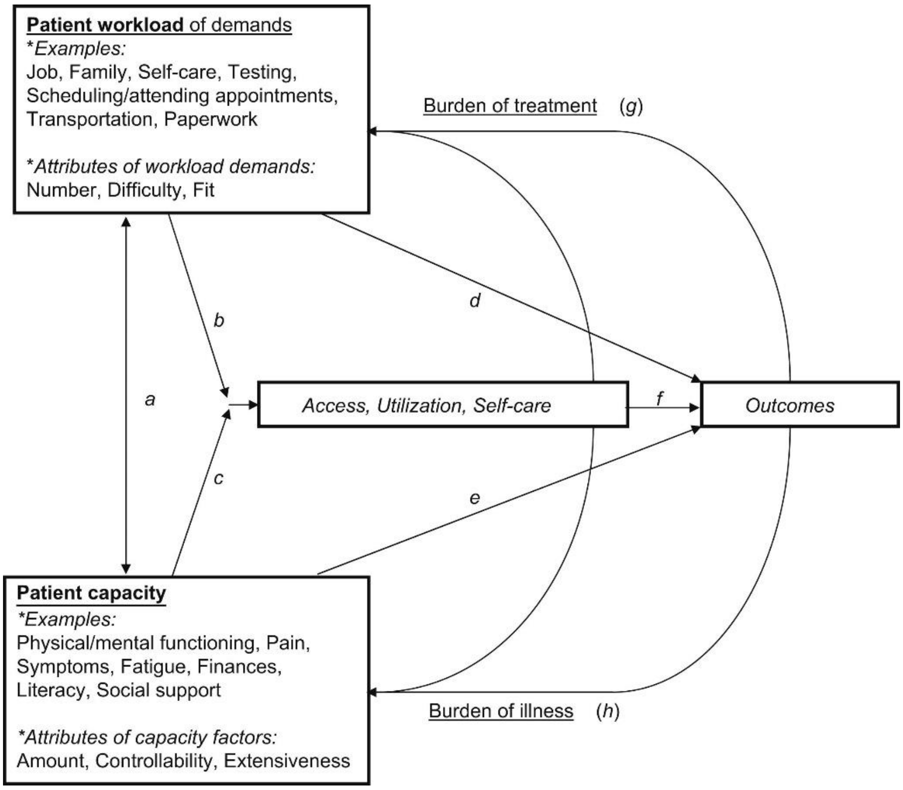


Figure 3-5: The Cumulative Complexity Model. From Shippee et al (2012).

Uncovering the concept of treatment burden itself has obvious implications for Burden of Treatment Theory. In a systematic review of qualitative evidence by Gallacher et al. (2013), discussion of treatment burden was present in many studies but none of the included papers (n=69) stated that it was an objective of investigation. Studies since have sought to measure treatment burden, both in patients with complex chronic conditions (Eton et al., 2012; Tran et al., 2014; Tran et al., 2012) and specifically with multimorbidity (Duncan et al., 2018). Others have sought to clarify what the concept means, defining treatment burden as a dynamic, multidimensional phenomena which comprises both subjective and objective burdens (Sav et al., 2015).

A further step towards the development of Burden of Treatment Theory outlined by May et al. (2014) is the reframing of self-care as an activity requiring an “embodied, practical knowledge that is very different from the abstract, rational model of patient knowledge” which typifies many self-management programmes designed to empower ‘expert patients’ (Pickard and Rogers, 2012, p. 116). The illness work, emotional work, and everyday work of patienthood was also recognised to be shared amongst wide and varied relational networks comprising family, friends, colleagues, healthcare professionals, pets, support groups, and others (Vassilev et al., 2013).

Drawing on these sources and others, Burden of Treatment Theory was developed as a structural model to explain how workload and capacity are balanced between patients and their relational networks. The next section provides an overview of the theory.

3.4.2 Description of Burden of Treatment Theory

The following description of Burden of Treatment Theory paraphrases the work of May et al. (2014). The way in which workload and capacity are balanced is described using four generative mechanisms. There is a fifth mechanism which relates to the way interventions can link these concepts and therefore avoid overloading capacity. The first four mechanisms are reproduced in Figure 3-6.

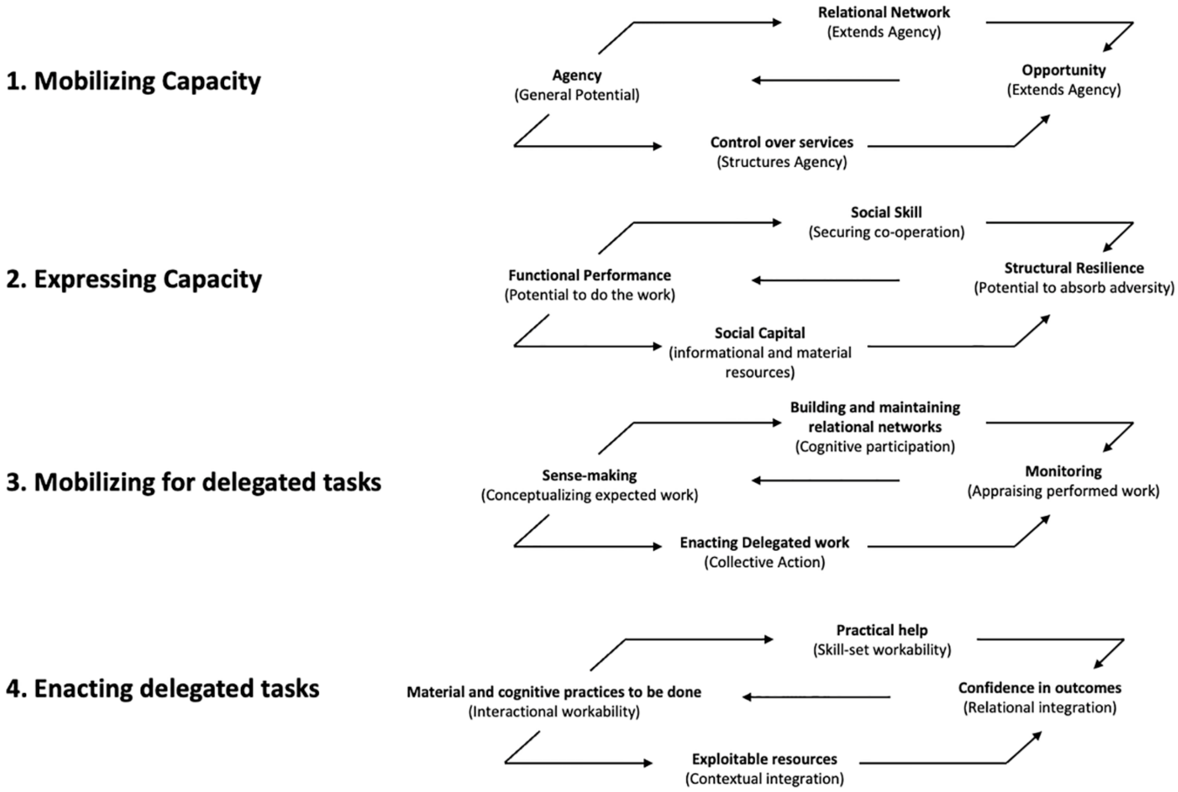


Figure 3-6: Burden of Treatment Theory: a summary of the four generative mechanisms which describe the balance between workload and capacity. From Chikumbu et al (2022).

The first mechanism describes how capacity is mobilised at the level of individual patients. The agency or general potential of an individual to interact with health services and treatments is mediated through their physical and mental health, comorbidities, and disabilities. The relational network (comprising friends, relatives, carers, healthcare staff and other professionals) extends agency, furthering the extent to which an individual can act. Agency is also structured by the professional roles, guidelines and normative practices which govern the way healthcare is provided. Finally, opportunities to access services are often unequally distributed (either geographically, temporally, or by characteristics such as age, gender or clinical status); this then informs the general potential of an individual agent.

The second mechanism describes how capacity is expressed at the structural level, where patients and their wider social networks are the unit of analysis. The functional ability of these networks is extended by their social skill (the ability to recruit and mobilise others), and social capital, or the ability to tentatively add network members through whom informational and material resources can be secured. The structural resilience of the network (or its potential to absorb adverse events such as worsening illness or biographical disruption) also mediates the extent to which capacity can be expressed, informing the baseline functional performance of the network.

In the third generative mechanism, patient work is outlined at a structural level using four structures recognisable from the earlier discussion of NPT. For patients and their relational network to enact delegated work, they must conceptualise or make sense of the tasks, and participate in the cognitive work of building and maintaining these relational networks. There is also the need to reflexively monitor or appraise the work, with this appraisal feeding into how the work is conceptualised.

In the fourth mechanism, the process of enacting this work is described at the granular level of individual patient networks. The work, or the material and cognitive practices to be done require that the patient and their relational network have access to practical help and exploitable resources, and also that they have confidence in the outcomes which will be achieved as a result of this work. This process informs the interactional workability of the tasks.

Burden of Treatment Theory also outlines – based on the mechanisms described above – how interventions should be structured to limit the potential for workload to overload capacity. This mechanism is presented in Figure 3-7.

Figure 3-7: Interventions which link capacity and workload. From May et al (2014).

For interventions to link capacity and work, they must involve maximising the collective competence of patients and network members, so that they have the skills required to undertake delegated work. They must build and strengthen relational networks around the patient, so that they can effectively navigate the healthcare system. They must also enable networks to secure cooperation and to access social capital in order to compensate for deficiencies in functional performance and to build structural resilience. Finally, there must be control over the burden of cognitive and practical tasks which are delegated, in order to avoid overload.

3.4.3 Applications of Burden of Treatment Theory

Burden of Treatment Theory has been applied in a wide range of settings, and to a variety of populations (Gallacher et al., 2022). It has provided a framework for analysis in evidence syntheses (Austin et al., 2021b; Jakubowski et al., 2022; O'Connor et al., 2016; Rosbach and Andersen, 2017), co-design workshops (Knowles et al., 2018), the development of an intervention for women experiencing domestic violence (Tarzia et al., 2016), and for qualitative studies involving diverse populations including people with palliative conditions attending the emergency department (Green et al., 2019), primary care users in Ontario, Canada (Kelley et al., 2020), people in the UK receiving novel therapies for cancer (Litchfield et al., 2023), receiving digital interventions for hypertension (Morton et al., 2018), and people with multimorbidity in urban and rural Malawi (Chikumbu et al., 2022) and South Africa (van Pinxteren et al., 2023). This list is not exhaustive; it simply serves to illustrate the applicability of the theory and to justify its adoption as an analytic framework for the qualitative phase of this thesis.

3.5 Micro-range theories

Alongside the middle-range Burden of Treatment Theory, several micro-range theories were employed at different stages in the thesis. As outlined earlier, these range in scope between those which overlap with middle-range theories but are smaller and less applicable to diverse populations, to simple hypotheses or propositions made by the researcher (Higgins and Moore, 2000). This section describes these theories.

Most of the theoretical constructs discussed in this chapter were decided a priori and built into the design of the studies. However, two micro-range theories – uncertainty tolerance (Hillen et al., 2017) and total uncertainty in multimorbidity (Etkind et al., 2022) – were incorporated during the analytical phase of the qualitative study. These are also discussed here, in order to provide a comprehensive overview of the theoretical models which will be encountered during the research.

3.5.1 Uncertainty tolerance

Hillen et al. (2017) proposed an integrated conceptual model of uncertainty tolerance, based on the work of Han et al. (2011) amongst others. Following from a conceptual analysis, the authors defined uncertainty as:

> The set of negative and positive psychological responses - cognitive, emotional, and behavioral [*sic*] -provoked by the conscious awareness of ignorance about particular aspects of the world. (Hillen et al., 2017, p. 70)

The model also proposes that the uncertainty stimulus which creates the above response can be broadly categorised as being either related to probability, ambiguity, or complexity. Explanation and examples of this are in Figure **3-8**.

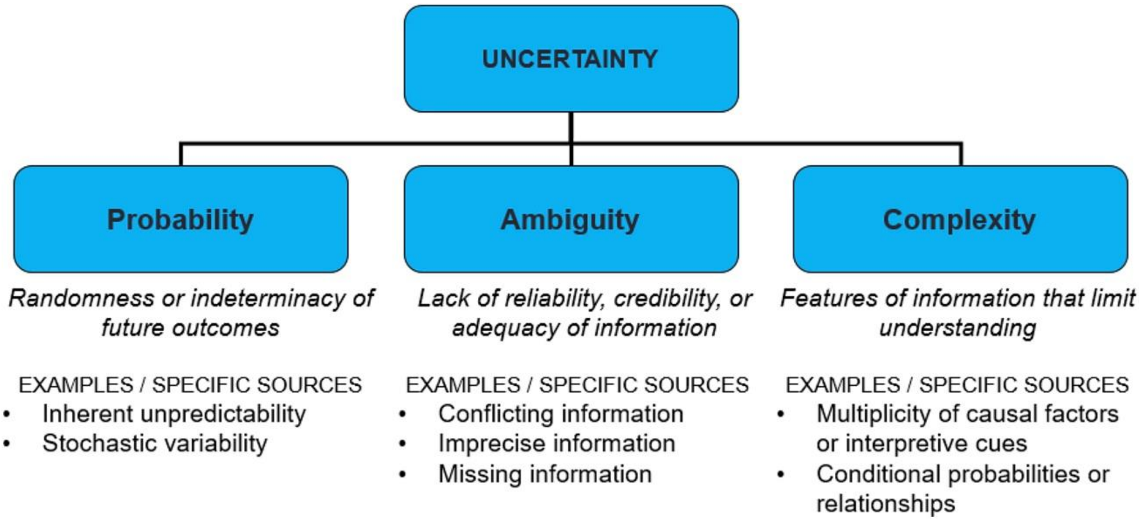


Figure 3-8: **Types of uncertainty. From Hillen et al (2017), based on Han et al (2011).**

The model theorises that these stimuli trigger the perception of uncertainty, this perception is moderated (or exacerbated) by the characteristics of the individual, the stimulus, the situation, as well as social and cultural factors. As outlined in the definition above, this results in cognitive, emotional and behavioural responses which can range from negative (i.e., denial, fear, inaction) to positive (i.e., faith, courage, action). The overall model of uncertainty tolerance proposed by Hillen et al. (2017) is summarised in Figure 3-9.

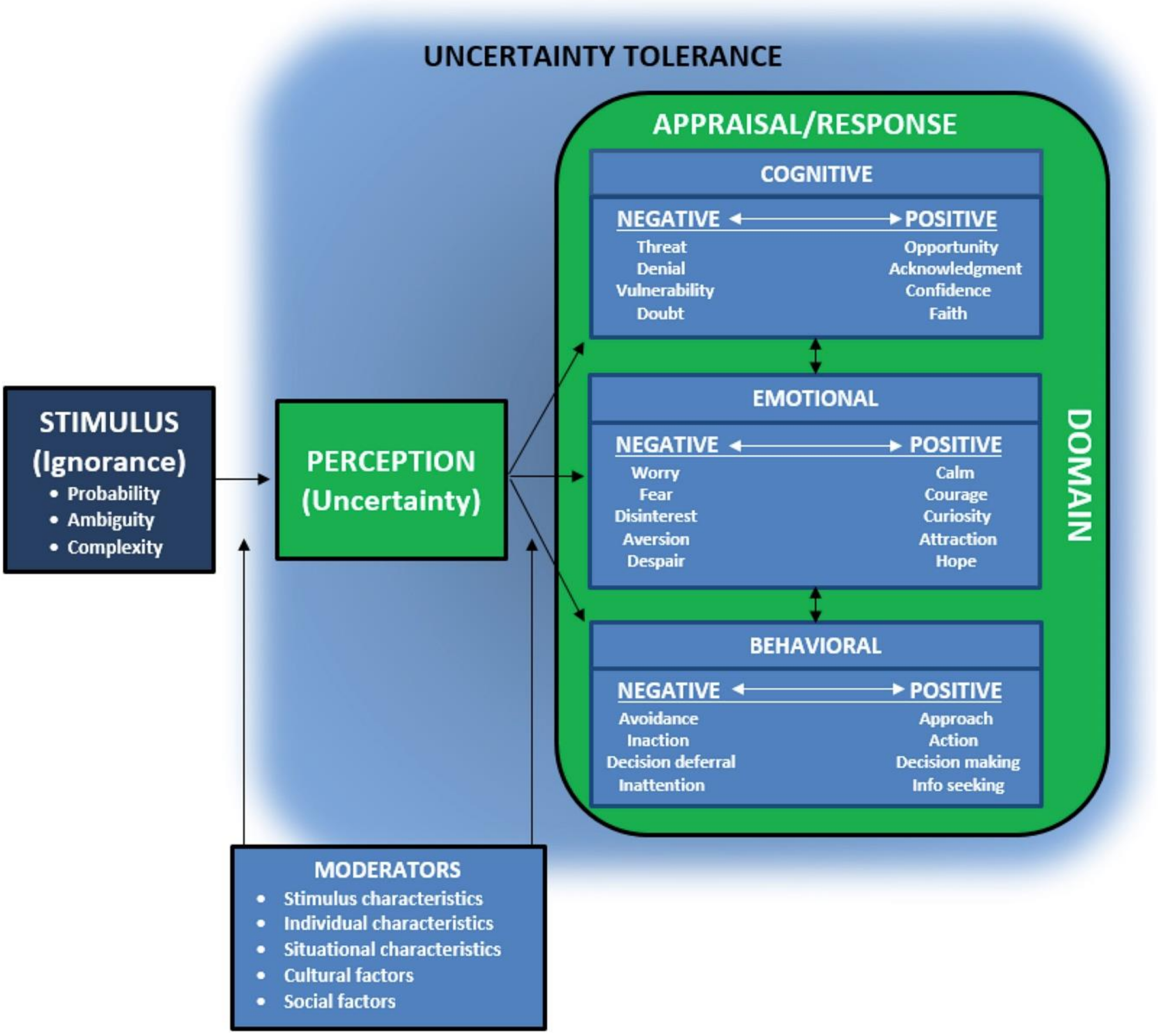


Figure 3-9: An integrative model of uncertainty tolerance. From Hillen et al (2017), based on Han et al (2011)

3.5.2 Total uncertainty in multimorbidity

Etkind et al. (2022) developed a model of total uncertainty to explain the uncertainty experienced by older people with advanced multimorbidity (operationally defined as multimorbidity with markers of advanced disease, based on Mason et al. (2016)). In their qualitative systematic review, the authors proposed that the experience of uncertainty in this group was characterised by five phenomena: appraising and managing multiple illnesses, fragmented care and communication, feeling overwhelmed, uncertainty of others, and continual change. Their model of total uncertainty is reproduced in Figure 3-10.

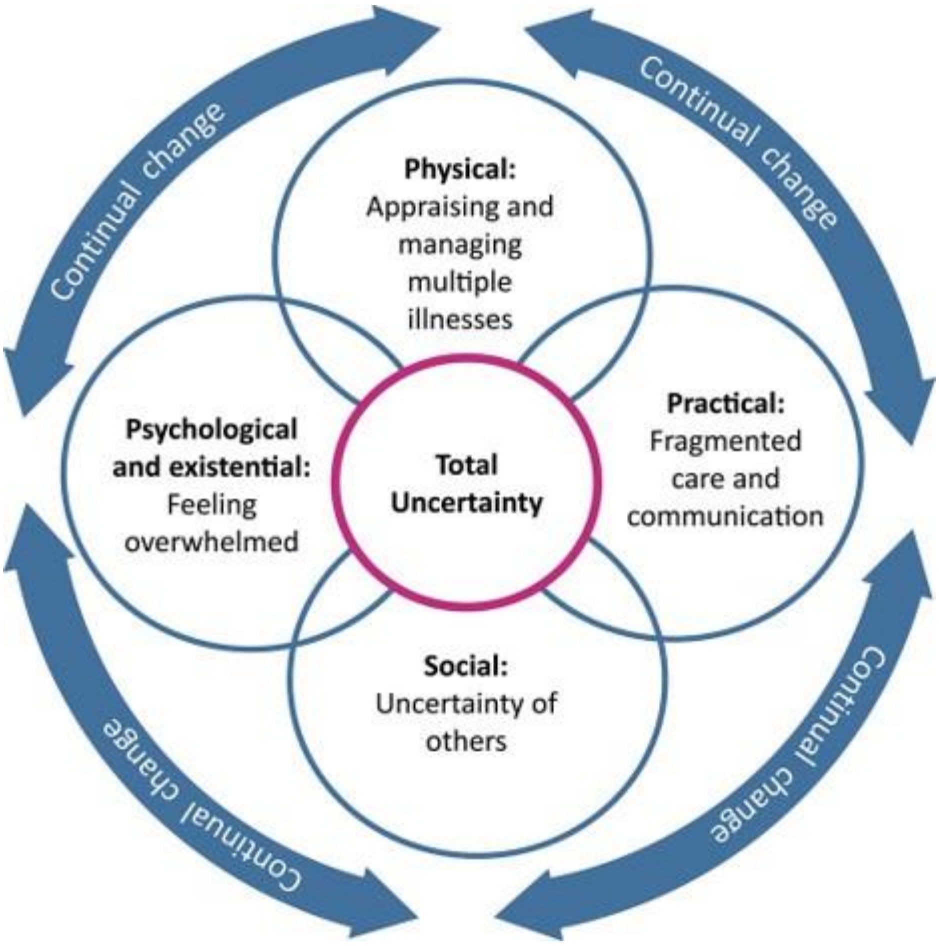


Figure 3-10: Total uncertainty. From Etkind et al. (2022).

Physical uncertainty relates to the complexity associated with having multiple illnesses, practical uncertainty stems from navigating fragmented care and communication with healthcare services, social uncertainty describes being uncertain about others (including healthcare professionals), while psychological and existential uncertainty is the feeling of being overwhelmed by the complexity and the experience of uncertainty itself. Etkind et al. (2022) propose that these dimensions of uncertainty exist in a state of continual change, across time and the trajectory of multiple illnesses.

The model of total uncertainty is based on the experiences of people with multimorbidity, the people who care for them, and healthcare professionals. In the context of this thesis, it is only applied to the experience of patients and carers, as there were no healthcare professionals recruited to the phase of the research where the concept of uncertainty is explored.

3.5.3 EPOC Taxonomy of interventions

The Cochrane Effective Practice and Organisation of Care (EPOC) taxonomy of interventions (EPOC, 2015) was used in the systematic review to classify interventions, alongside inductive generation of new categories where necessary. The EPOC taxonomy was specifically designed to assist review authors in classifying interventions, and is intended to be adapted, added to and disaggregated as necessary (EPOC, 2016). It was also used in a recent Cochrane review of multimorbidity interventions (Smith et al., 2021).

3.5.4 Falsifiable hypotheses

A final comment on theory relates to the generation of hypotheses which was a necessary step in the conduct of the quantitative phase of this thesis. Testable hypotheses which are not grounded in larger theoretical models are at the bottom of the hierarchy of theoretical thinking (Higgins and Moore, 2000), but nonetheless require the researcher to theorise relationships or causal mechanisms before empirical testing. Based on the findings of the systematic review (and the emphasis on measuring health service-related outcomes), it was assumed that multimorbidity would be significantly associated with healthcare use and inpatient mortality. These assumptions were framed as a priori hypotheses, which allowed for statistical tests to be performed resulting in the decision to either accept or reject the hypotheses.

3.6 Theoretical framework

So far in this chapter, the rationale has been provided for the overarching meta-theoretical approach (critical realism), alongside the middle and micro-range theories which will be applied throughout the various stages of the research. The overall theoretical framework is summarised in Table 3-2.

Theory type	Theory and citation(s)	Key assumptions
Meta-theory	Critical realism	A realist ontology: reality cannot be directly observed, but causal inferences can be made based on empirical observation. Retroductive reasoning allows for generation of theories to explain observed events. Epistemic relativism allows for co-existence of multiple intransitive theories to explain transitive events.
Middle-range theory	Burden of Treatment Theory	Engagement with healthcare activities is dependent on the balance between capacity and workload. Capacity is extended through relational networks, material/informational resources, social skill and social capital. Capacity can be overwhelmed, resulting in poor outcomes.
Micro-range theories (higher-level)	Uncertainty tolerance	Uncertainty is the conscious awareness of ignorance about something. The response to uncertainty is mediated by a range of extrinsic and intrinsic factors. Responses to uncertainty can range from positive to negative, and can be cognitive, emotional or behavioural.
	Total uncertainty	Uncertainty in multimorbidity is multidimensional and exists in a state of continual change. It is characterised by four phenomena: appraising and managing multiple illnesses, fragmented care and communication, feeling overwhelmed, and uncertainty of others.
	EPOC taxonomy of interventions	Healthcare interventions can be classified using this taxonomy, with adaptions made as necessary.
Micro-range theory (lower-level)	Falsifiable hypotheses	Hypotheses can be proposed and tested using empirical methods, but they are open to being falsified by contradictory results.

Table 3-2: Theoretical framework for the thesis

3.7 Methodological decisions

Having now outlined the theoretical framework of the thesis, this section will describe the rationale for adopting a sequential triangulated mixed-methods approach. Both quantitative and qualitative approaches will be discussed, alongside some justification for why neither approach was thought to be sufficient to achieve the aims of the research alone.

3.7.1 Why quantitative methods?

As discussed earlier, quantitative methods are grounded in the positivist (or post-positivist) philosophy of science. Central to this approach is the ontic assumption that the natural world is stable and the epistemic assumption that it can be observed in the same manner employed by the natural sciences (Bruce et al., 2018), through experimentation and observation which is value-neutral and unaffected by the scientist studying it. This epistemology is hypothetico-deductive (i.e., hypotheses are tested resulting in deductive conclusions which may be falsified by future research resulting in modified hypotheses (Popper, 1959)) or inductive (i.e., data is observed leading to the generation of new hypotheses or conclusions) (Bruce et al., 2018).

The quantitative phase in this sequential mixed methods project comes after a mixed methods systematic review, and the aims of the quantitative study are based on the findings of the review. The specific methods employed are outlined in the following chapter, however, for the purposes of this section it is sufficient to state that these aims comprise falsifiable hypotheses, and that the methods for testing these hypotheses were by necessity quantitative (logistic regression). The questions asked by the quantitative phase relate to large populations, and assessing whether these populations are at higher risk of experiencing certain outcomes. There is a need, therefore, to assume a cause-effect relationship between the exposures and outcomes under investigation. This does not necessitate a positivist philosophy of science (as discussed, critical realism accommodates these assumptions), but it does require a quantitative methodology.

The argument against conducting this research using a purely quantitative approach closely mirrors the reason for rejecting the positivist paradigm. Research involving humans is always grounded in the social, historical, and necessarily complex world in which humans exist, therefore applying the methods of the natural sciences alone cannot provide a sufficient understanding of this world. As Green and Thorogood explain:

> Unlike atoms (or plants or planets), human beings make sense of their place in the world, have views on researchers who are studying them, and behave in ways that are not determined in law-like ways. They are complex, unpredictable, and reflect on their behaviour. Therefore, the methods and aims of the natural sciences are unlikely to be useful for studying people and social behaviour… (Green and Thorogood, 2018, p. 41)

As such, the quantitative methods employed in this thesis provide only part of the picture; an in-depth understanding of some of the key problems faced by the target population will be achieved using a qualitative approach.

3.7.2 Why qualitative methods?

Qualitative methods are generally grounded within the interpretivist paradigm, dealing with "'what', 'why' and 'how' questions rather than 'how many'" (Ormston et al., 2013, p. 3). Compared with quantitative methods' aim to establish causal relationships and theories as part of a progression towards complete knowledge of a subject, a qualitative approach aims to produce situated, meaningful, and socially-mediated knowledge (Braun and Clarke, 2022). Given the reasons for rejecting a purely quantitative approach in this thesis, it should be clear that qualitative methods provide a means through which the in-depth understanding of the study population can be achieved.

The qualitative phase of this thesis comes after the systematic review and the quantitative phase, and its design was informed by the questions raised during these phases, in particular the systematic review. The aims of the qualitative questions relate to understanding the culture of patient-carer groups who are linked through a shared experience. The questions relate to 'how' people experience phenomena, 'what' role carers play, and 'how' care can be improved. These are questions which cannot be satisfactorily answered with quantitative data, necessitating the incorporation of qualitative methods.

It has already been outlined why a quantitative component was necessary, and the argument for a qualitative component is similar. While quantitative methods allow for generalisations to be made about large populations about risk and causal relationships, qualitative methods permit a glimpse into the "'black box' of how social phenomena are constituted" (Silverman, 2016, p. 3). It is this complementary and comprehensive approach to knowledge acquisition which drove the decision to conduct a mixed methods project.

3.7.3 Sequential triangulated mixed methods design

The decision to consider both qualitative and quantitative approaches in this thesis was driven by the assessment of what the different approaches could contribute towards the area of enquiry; however, the decision to integrate findings under a theoretically guided mixed methods design is a result of the critical realist approach to knowledge. This approach involves retroductive reasoning, or making inferences and building theoretical models based upon observed data. While purely positivist-quantitative methods are restricted to empirical observation and eschew claims about unobserved social structures, the interpretivist-qualitative approach often rejects retroductive inferences based on the assumed intangibility of such social structures (McEvoy and Richards, 2006). Critical realism allows for such retroduction, recognising its necessity in conceptualising the unseen causal mechanisms which manifest empirical phenomena. As such, the use of mixed methods in this thesis requires synthesis of the findings from both qualitative and quantitative phases, and this process can be described as both sequential and triangulated.

The chronology of phases in mixed methods research is important. Researchers can employ designs which are parallel (phases are conducted simultaneously), convergent (simultaneous phases converge to reach conclusions), or sequential (phases follow one after another and are informed by preceding phases) (Östlund et al., 2011). Distinctions can also be made between the way that findings are synthesised from mixed methods studies. The term 'triangulation' is used to cover a range of activities undertaken by researchers to improve the quality of research; in this instance what is being described is methodological triangulation (Denzin, 2009), where the aim is to apply a range of methods to a single area of enquiry. The quality of mixed methods research in nursing has been criticised for poor reporting of how integration of findings and triangulation occurs (Bressan et al., 2017; Irvine et al., 2020; Younas et al., 2019), and there have been calls for better use of theoretical models to describe how this is achieved (Östlund et al., 2011).

The specific means through which sequential triangulation will occur in this thesis is as follows:

- The quantitative and qualitative findings in the mixed methods systematic review will be analysed convergently.
- The design and aims of the quantitative phase are informed by the findings of the systematic review.
- The design and aims of the qualitative phase are informed by the findings of the systematic review and the quantitative phase.
- The final analysis and discussion will be informed by all three phases.

It is important to highlight that while the above description may seem to represent a narrow and sequential line of enquiry, the practical application of this approach was more wide-ranging. This is particularly evident following the systematic review, where the phases diverged to explore the problem of multimorbidity from a health-systems (quantitative phase) and patient-centred (qualitative phase) perspective.

3.8 Specific issues related to quantitative methods

In the preceding section the overarching rationale for the inclusion of quantitative methods in the thesis was described. This section addresses some of the specific aspects of the methods employed.

3.8.1 Data Safe Havens

In Scotland, there is a federated network of data Safe Havens which are supported by universities, and offer researchers secure access to routinely-collected patient data under rigorous governance procedures (The Scottish Government, 2015).

The ‘Scottish model’ of harnessing administrative healthcare data is focussed on balancing contemporary public attitudes towards the use of such data with the requirements of researchers, while operating within Scotland’s legal and governance frameworks (Pavis and Morris, 2015). Figure **3-11** below provides a summary of how this model works within the context of a data Safe Haven.

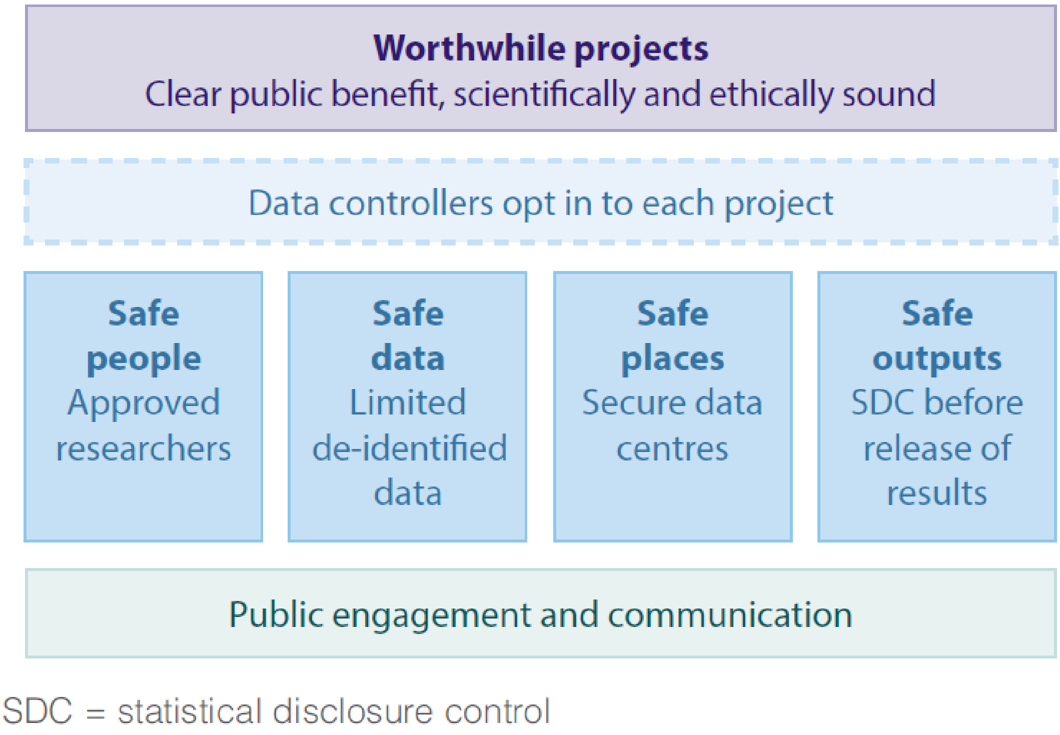


Figure 3-11**: The 'Scottish Model' of unleashing the power of administrative data. Reproduced from Pavis & Morris (2015)**

Proposed research using administrative data undergoes an ethical approval process, during which the research and researchers are assessed for their suitability. Data is de-identified by Safe Haven personnel and access to the data is provided only via a secure (physical or virtual) space. Any research outputs generated by the researcher must further undergo review by Safe Haven personnel to avoid any risk of disclosure, prior to being exported from the secure platform. The responsibility for ethical review at the West of Scotland Safe Haven is delegated to a Local Privacy Advisory Committee (LPAC).

3.8.2 Routinely collected healthcare data

The use of routinely-collected healthcare data for research is an increasingly common practice, and one which has many advantages. It allows researchers access to potentially large datasets which contain data collected in a more naturalistic setting, therefore potentially increasing generalisability (Hemkens et al., 2016).

However, there are also potential drawbacks. A significant amount of the value placed on routinely collected data is predicated on the above assumption that it is accurate and less prone to biases introduced during the research process, but data collected during routine clinical practice (when the collection of data is not the primary objective) can also be inaccurate or incomplete (Nicholls et al., 2017). In most instances, there is a human component to the coding of healthcare data (particularly with diseases using a classification system such as ICD-10) and it is therefore susceptible to error.

This critique is not intended to undermine the value of working with routinely-collected data, rather it reinforces the need to ensure that data is collected in a reliable and accurate manner, and that researchers report findings comprehensively. There are several ways in which the collection of routine data could be improved, such as harmonising mandatory items across datasets, using natural language processing and artificial intelligence to improve documentation and extraction of free text, and better training in and standardisation of taxonomies used to classify diseases (McGuckin et al., 2022), but ultimately the researcher has little or no influence over these factors. Fortunately, specific guidelines exist which enable researchers working with routinely collected data to report their findings in a way which allows the user to appraise the quality of their research. The Reporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement (Benchimol et al., 2015) provides a comprehensive checklist of information which must be included in a publication detailing findings from an observational study using routinely-collected data. In order to ensure a high quality for reporting the results of the quantitative findings in this thesis, these are reported using the RECORD checklist in Appendix 1.

3.8.2.1 Secondary analysis of routinely collected data

The data extracts which were used for the quantitative study were not prepared for this particular study. In this sense, as well as being a study using routinely-collected data, the quantitative phase of this thesis could also be considered a secondary analysis of quantitative data. Secondary analysis has benefits in terms of saving time and money, but there is also the risk that the data may not be suitable for the planned project (Dunn et al., 2015). However, in this instance it was possible to ensure the suitability of the data extracts prior to commencement of the planned study.

Due to rigorous standardisation in the way data extracts are coded in the Safe Haven, alongside easily-accessible data manuals which describe these coding practices, it was possible not only to ensure that the data contained the necessary fields and date range to allow the aims of the study to be addressed, but also to develop randomly-generated datasets outside of the Safe Haven which adhered to the prescribed structure. This meant that test code could be piloted prior to the commencement of the study and imported into the Safe Haven platform, allowing it to be further developed using the real data.

The COVID-19 pandemic caused the order of the phases of the research to be changed, meaning that the commencement of the quantitative phase was brought forward. It was through leveraging professional networks that expedited access to data extracts prepared for a different programme of work was secured. This allowed for both financial and time savings to be made, offsetting some of the disruptive effects of the pandemic. The only limitation resulting from the decision to undertake a secondary analysis related to reduced access to historical inpatient data, which is discussed later in the thesis (Strengths and limitations, page 238).

3.8.2.2 Handling missing data

A final dimension to consider with regard to the use of routinely collected data is how to handle missing data. While this is not a problem unique to observational studies of this nature, the patterns and reasons for missing data may differ from those which drive missing data in a randomised controlled trial, for example.

Particular care has to be exercised when the data which is missing is demographic data related to protected characteristics such as race or sex. If missing data of this nature is not handled correctly, then there is the potential to reinforce existing biases, and if this data is used to train predictive models then these may biases may be built-in to the model. A useful example of this is provided in the US, where a model based on healthcare costs rather than levels of illness may ignore the potential for some ethnic groups (disproportionately affected by poverty and less able to spend on healthcare) to have needs which outstrip their spending ability. The result is skewed resource allocation to white patients who are more likely to have insurance coverage or spending levels commensurate with their needs (Obermeyer et al., 2019).

For this reason, the decision was taken to use a random forest classification algorithm (Stekhoven, 2022) to handle instances where large volumes of data related to protected characteristics was present. This algorithm has been shown to outperform several other popular machine learning algorithms in the classification of complex non-parametric data (Stekhoven and Buhlmann, 2012). Importantly, as it produces a single aggregate value for each missing item based on the output of randomly-generated decision trees, it does not require pooling of multiple results prior to analysis as in other types of multiple imputation (Austin et al., 2021a).

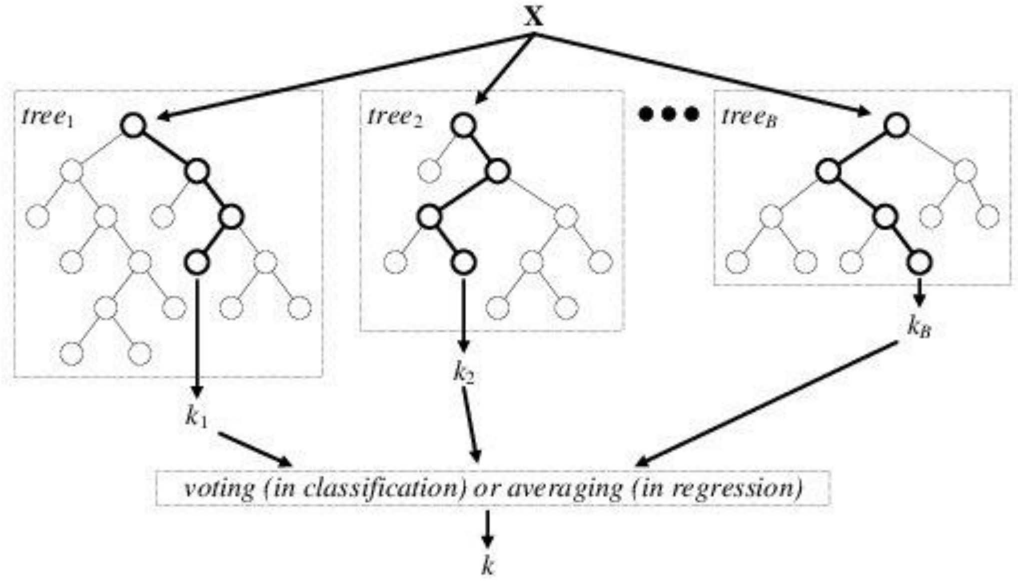


Figure 3-12: Architecture of a random forest algorithm. Reproduced from Verikas et al (2016).

Random forest classification algorithms (pictured above in Figure 3-12, reproduced from Verikas et al. (2016)) generate multiple decision trees for each instance of missing data, however, each tree is only allocated a random selection of variables upon which to decide on the missing value. This process of bootstrap aggregation (often referred to by its contraction, ‘bagging’) means that random forest algorithms are well-suited to high-dimensional data and while they are mathematically complex, they are conceptually easy to understand, interpret, and to deploy (Biau and Scornet, 2016). In the above example, the trees generated for each instance make use of different variables to reach a classification decision, before voting on the most probable value.

Models such as this do not always perform as well when data is not missing at random, however. Complete-case analysis is an appropriate method of analysis when data cannot be assumed to be missing at random (Jakobsen et al., 2017), therefore it was decided to conduct two parallel analyses (complete-case and post-imputation) if significant data were missing. This would permit qualitative comparisons to be made between the two sets of results (i.e., determining if there were any marked differences in the direction or strength of effect).

3.8.3 Defining and identifying multimorbidity

The conceptual definition of multimorbidity has been discussed in the preceding chapter (page 15), however from an epidemiological position and in the context of the quantitative phase of the thesis this merits further attention. Several frameworks have been proposed for measuring multimorbidity, and they are often designed for different purposes. A recent systematic review (Stirland et al., 2020) identified 35 potential indices which incorporated various dimensions of multimorbidity beyond disease-count, including medication burden, physiological parameters, and demographic variables. Indices are often limited by the purpose for which they are designed or the population in which they have been validated; Stirland et al. (2020) use the example of the Charlson Comorbidity Index (Charlson et al., 1994); developed for prognostication of mortality in hospital inpatients, it assigns a disproportionately high weighting to HIV given the advances in treatment which have occurred in the 30 years since it was validated. Another well-known index first validated by Elixhauser et al. (1998) often performs better than the Charlson Comorbidity Index in prognostication and prediction of healthcare use (Cai et al., 2020; Sharma et al., 2021), however, for the purpose of this thesis the aim was to find a method of identifying people with multimorbidity using conditions which were prevalent in the population under study.

A seminal epidemiology of multimorbidity was published in the Lancet by Barnett et al. (2012), in which the prevalence of multimorbidity (defined as two or more conditions) was measured using a large sample of Scottish primary care data (n=1,751,841). The authors used a list of 40 chronic conditions which were identified as being important in the epidemiology of multimorbidity based on a previous systematic review (Diederichs et al., 2011), as well as NHS Scotland priorities and the NHS quality outcomes framework.

In a later study undertaken with a cohort of patients in Canada, Tonelli et al. (2016), identified methods of detecting 30 of these 40 conditions using routinely-collected patient data, through ICD-9 and ICD-10 codes. The 30 conditions included in this index were only those which were able to be validated with moderate to high reliability in the study cohort. Three of the 30 conditions were cancer diagnoses; in studies since these have been collapsed into a single diagnosis of cancer (Stokes et al., 2021).

The decision to adopt this approach in the current study was based on two factors. Firstly, the conditions which are included are relevant to the epidemiology of multimorbidity in a UK context, rather than for prognostication or other specific purposes such as with the Charlson and Elixhauser indices. Secondly, measuring multimorbidity should be done with a comprehensive and transparent index with a minimum of twelve conditions (Fortin et al., 2012). The methods outlined by Tonelli et al. (2016) and Stokes et al. (2021) allow for the identification of 28 conditions, and by operationalising transparent algorithms which use ICD-10 codes, the method permits comparisons to be made with different populations.

3.8.4 Machine learning

A short discussion of machine learning is also merited in this section. The quantitative phase of this thesis does not proceed to the stage of training and testing a predictive model, but it is predicated on the assumption that this is a means by which interventions can be targeted.

The ubiquity of machine learning algorithms can be felt in almost all aspects of daily life, from the accuracy with which streaming services can predict which programmes a user will want to watch, to the targeting of advertisements which proliferate web browsers and social media sites. Such technologies are already routinely used in healthcare for a variety of purposes, and despite many being grounded in familiar statistical methods and processes already used for risk stratification, the concept of machine learning remains a source of mystery for many people who work in healthcare (Beam and Kohane, 2018).

In simple terms, machine learning algorithms are “computational algorithms that are designed to emulate human intelligence by learning from the surrounding environment” (El Naqa and Murphy, 2015, p. 3). When coupled with sufficient computational power, such algorithms can detect associations or predict/categorise values in extremely large data sets. Some of the models which have attracted media attention in recent years include deep learning models or artificial neural networks (which have been shown to perform as well as clinicians in the interpretation of certain types of diagnostic imaging (Beam and Kohane, 2018)), or generative adversarial networks, in which one model attempts to produce an output (such as an image) based on vast amounts of input data, while another model assesses the likelihood of the output being or accurate (the method commonly deployed by AI image generators (Goodfellow et al., 2020)). Both of these approaches work on extremely large volumes of unstructured data with limited input from a human, therefore they are described as *unsupervised* machine learning models.

The type of model which is relevant to this thesis is known as a *supervised* model. In the diagram from Handelman et al. (2018) below (Figure **3-13**), the distinction between these model types is illustrated.

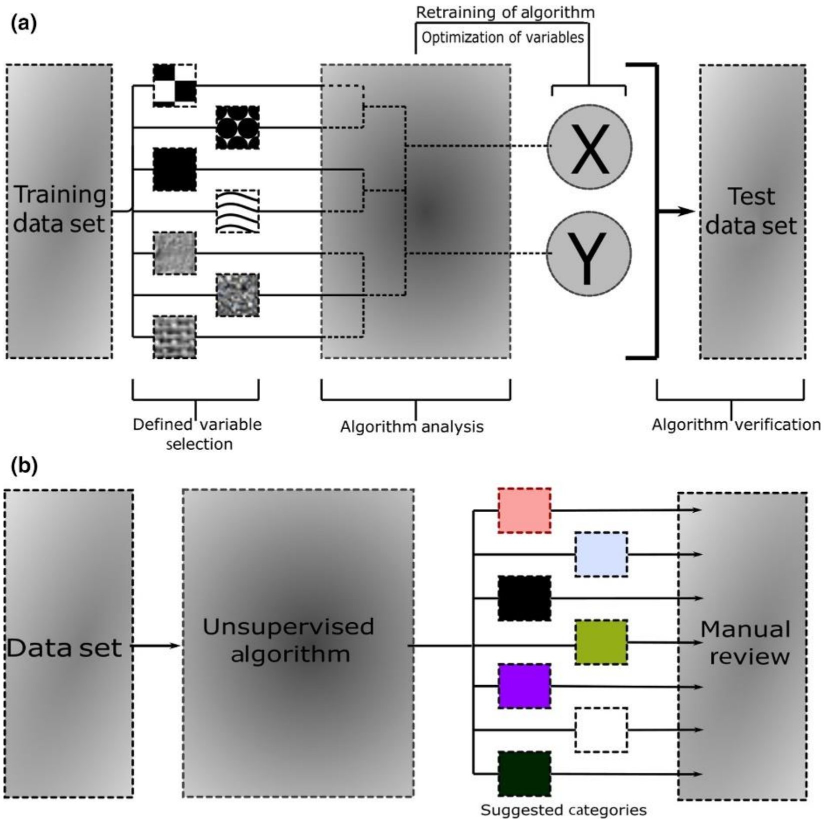


Figure 3-13**: Differences between supervised and unsupervised machine learning models. From Handelman et al (2018).**

In (a), the human operator pre-defines which variables are in the data set, and the algorithm is exposed to a portion of the data (training data set) and tasked with assigning a value of X or Y to a separate variable, dependant on the observed values of the other variables. The human operator then assesses the accuracy of the model by exposing it to the test data set and checking the accuracy of its predictions. There is scope to alter various parameters within the model during an iterative testing process, ensuring that the model fits the data.

In (b) the model is exposed to the entire dataset and in effect seeks out relationships between the unstructured data before presenting these as an output for manual review by a human operator.

The relevant process in the context of this thesis is that described in supervised model (a). While this project does not proceed to the point of training and testing a model, it seeks to identify whether certain variables (multimorbidity, complex multimorbidity and disease-count) are significantly associated with negative outcomes. If these hypotheses are true, then the argument can be made for the inclusion of these variables in other supervised machine learning models to aid risk stratification and the targeting of interventions for this patient group.

3.9 Specific issues related to qualitative methods

This section addresses some of the specific aspects of the qualitative methods employed in the thesis.

3.9.1 Quality in qualitative research

Considering the quality of qualitative research requires a different approach than that which is employed when comparing quantitative studies. The metrics through which studies are evaluated are not universally agreed, and it can be argued that the application of the same metrics to studies from different qualitative traditions does a disservice to one or both studies. Writing more than 20 years ago, Clive Seale observes:

> …the modernist headings of ‘validity’ and ‘reliability’ are no longer adequate to encapsulate the range of issues that a concern for quality must raise. Instead, we need to accept that ‘quality’ is a somewhat elusive phenomenon that cannot be pre-specified by methodological rules. (Seale, 1999, p. 7)

The perceived inadequacy of validity and reliability to encapsulate the breadth of issues which comprise the quality of a qualitative study does not mean they can be dispensed with entirely, however. Validity is a measure of how credible the findings of a study are; there are several ways in which researchers can try to demonstrate validity, a common example being where the researcher returns to participants with tentative findings and ‘checks’ the accuracy of their interpretation (Silverman, 2021). The methods employed in this thesis to ensure the validity of qualitative findings was by triangulating findings between different media (interviews, diaries, reflexive journals and observation), and by ensuring participant voices are adequately represented in the reporting of findings.

Reliability is concerned with the extent to which phenomena will be categorised or labelled consistently in qualitative research. One approach to producing reliable interpretations is the use of “low-inference descriptors” (Seale, 1999, p. 148), or labels which are relatively free of researcher judgement. However, it is not possible to entirely isolate the observer from the inference (Seale, 1999; Silverman, 2021), therefore an alternative method of arriving at more concrete descriptors must be sought.

Theory has been described at length in this chapter. With reference to reliability, the middle and micro-range theories provide defined concepts and terminology which can be used with relative consistency. Concepts such as agency, capacity, workload (May et al., 2014), uncertainty (Hillen et al., 2017), and total uncertainty (Etkind et al., 2022) are theoretically grounded in this thesis. However, limiting the vocabulary in this way should not be allowed to limit abstraction, otherwise this risks raising further issues about quality centred around the originality of the analysis.

In a discussion of how to assess the quality of qualitative findings for the purpose of evidence syntheses, Sandelowski and Barroso (2007) propose a hierarchical typology through which the quality of studies can be assessed (Figure **3-14**).

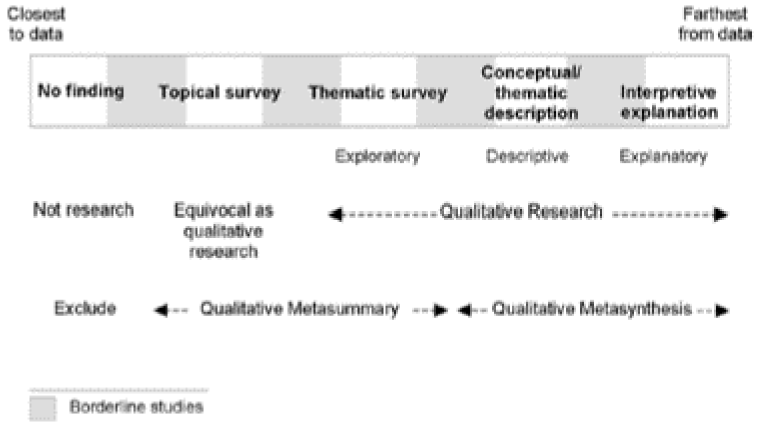


Figure 3-14: **Hierarchical typology of qualitative research findings by method of integration. From Sandelowski & Barroso (2007).**

In this typology, the lowest quality of study are those with the least interpretation of data. This requires some reconciliation with Seale’s (1999) advocacy of low-inference concepts. Sandelowski and Barroso (2007) argue that for qualitative research to be of a high quality, the researcher should achieve an interpretive analysis which has explanatory power, and one which moves beyond simple description or an exploration of common themes. The aim of this thesis is to produce such results, but to ground the interpretation in a priori theoretical concepts which are relatively well-defined. Abstraction is a necessary step in achieving this level of quality, but through giving adequate room to participants’ voices, this process of abstraction remains grounded in the data.

3.9.2 Reflexive thematic analysis

In discussing abstraction, it has been acknowledged that the researcher’s assumptions, and background cannot adequately be disentangled from these abstractions (Seale, 1999; Silverman, 2021). It remains, therefore, to find a way of reconciling this process with the desire to produce a qualitative analysis which goes beyond simple exploration or description.

From a critical realist perspective, the pursuit of entirely value-neutral knowledge detached from the social reality in which it is constructed is unachievable. In qualitative research, the rejection of such a premise is also common practice; the means by which researchers produce high quality interpretive analyses is by acknowledging and considering the impact of the researcher on the research, a process known as reflexivity (Ormston et al., 2013).

The specific analytical approach which will be employed is reflexive thematic analysis, as outlined by Braun and Clarke (2022). Reflexive thematic analysis is the most recent iteration of Braun and Clarke's approach to thematic analysis, first outlined in their 2006 paper *Using thematic analysis in psychology* (Braun and Clarke, 2006). The specific steps required in conducting thematic analysis are outlined in the next chapter, and have not changed greatly since their inception. The main difference in this approach is a renewed focus on the reflexive dimension of analysis.

The analytic process is grounded in the assumption that the researcher is situated in context, by their values, beliefs, assumptions, background and other dimensions of identity such as race, sex, gender, class, or profession. Reflexivity does not simply require the researcher to reflect on their own characteristics and how this affects the research and their interpretation; it is also expected that the impact of methodology, study design and the academic discipline within which the study is undertaken is reflected on (Braun and Clarke, 2022).

Throughout the qualitative phase of the thesis, this was done by keeping a reflexive journal. This was a series of documents in which the author of this thesis would reflect on the above factors as the study progressed, documenting personal reactions to events and challenging assumptions made. These documents were added to the final data for analysis, providing useful context on initial responses to interviews and other events which occurred.

3.9.3 Focussed ethnography

Ethnography originates from anthropological research traditions; it is associated with field-work and observation by an 'outsider' researcher, in order to understand cultures which are in some way different to the culture of the researcher (Cruz and Higginbottom, 2013; Gullion, 2016). Ethnographic principles have since been applied to a range of disciplines in order to understand social and cultural groups, including in nursing and health care research (Gullion, 2016).

People with a shared state of health (like multimorbidity) may not come into contact with one another; however, these individuals are linked through shared experiences and behaviours in a way that creates a geographically disparate culture. Exposed to such cultural stimuli, individuals learn to embody the role of a ‘person with a chronic condition’ (Morse, 2014). Ethnographic studies which comprise a focussed examination of these disparate groups linked by culture, they are sometimes referred to as *focussed* ethnographies (Muecke, 1994). Some of the key concepts which differentiate focussed ethnography from classical ethnography are summarised in Figure 3-15 from (Higginbottom et al., 2013).

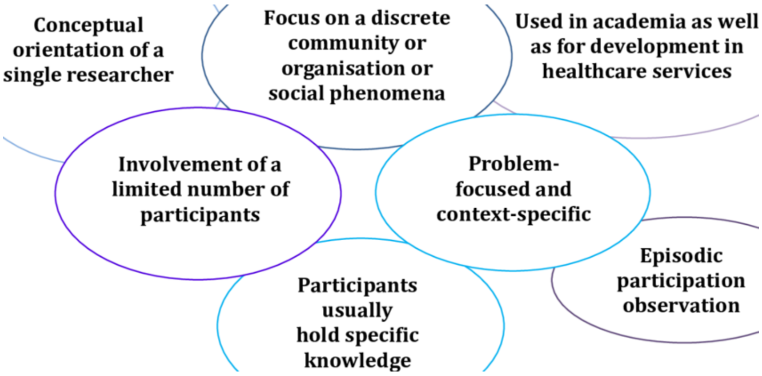


Figure 3-15: Common features of focussed ethnography. From Higginbottom et al (2013).

It is important to distinguish this phase of the thesis as a focussed ethnography. The differences between this and the more traditional ethnographic approach are small but significant. A focussed aim, short-term engagement with a relatively small sample, limited (or no) interaction between participants, episodic observation, and a single researcher with prior knowledge of the phenomena being studied are all indicative of a focussed ethnographic approach (Wall, 2015; Higginbottom et al., 2013). There are, however, some central concepts of ethnographic research which are retained in the focussed approach of this thesis. These include a focus on the participants as a cultural unit, the adoption of a holistic and non-judgemental orientation, considering the perspective of the participants as insider-members of a cultural group (emic perspective) and the perspective of the researcher as outsider (etic perspective) (Fetterman, 2020).

3.9.3.1 Semi-structured interviews

Qualitative interviews allow the researcher to understand events and experiences which occur in their absence, to construct narratives which account for complex processes and phenomena, and to collect large volumes of data encompassing a range of perspectives (Rubin and Rubin, 2005). Interviews have become one of the most frequently used tools available to qualitative researchers, and some argue that their ubiquity alongside participants' innate understanding of the role of interviewer and interviewee in a media-saturated world devalue the currency of this method (Brinkmann, 2013).

Interviews are, however, an integral part of the ethnographic approach and are of particular value when the researcher can use them to revisit concepts and themes which have arisen during fieldwork (Fetterman, 2020; Wall, 2015). For this reason, semi-structured introductory and closing interviews were conducted in this study, providing the opportunity to not only collect a wealth of data at the outset if the study, but also to revisit concepts and triangulate findings at the conclusion of a participant's involvement.

3.9.3.2 Journalling

Interrogating written materials made by participants can be an effective way for an ethnographer to understand a culture or phenomena (Fetterman, 2020), however this assumes that such documents exist and are accessible to the researcher. The rationale for including participant journals in this study was to provide participants with a way of documenting their experience in their own words.

Unstructured diaries in qualitative research allow participants to construct narratives of how they experience and understand phenomena without the mediation provided by a researcher in the context of an interview (Kaun, 2010). Diaries can also elicit contemporaneous accounts of phenomena in a way that interviews conducted at a later date cannot (Rudrum et al., 2022). In isolation, the vast amount of unstructured data generated by participant diaries may seem ill-fitting for focussed ethnographic enquiry, however, as part of a multi-modal approach to data collection they provide another means through which individual experiences can be understood.

3.9.3.3 Observation

In classic ethnography, a researcher may embed themselves in a culture, participating in their society and observing their rituals and customs over a period of months, if not years (Fetterman, 2020). This intensity of observation is often not present in focussed ethnography, dealing as it frequently does with geographically dispersed cultural units who may have little or no interaction with one another (Wall, 2015).

Observation sessions were an optional component of the study. However, it was felt to be an important component as the relationship between an individual and their environment can impact on their perceptions of health and the care they receive (Carpiano, 2009). Previous research indicated that travel plays a significant role in the way an individual experiences treatment burden (Duncan et al., 2018) therefore the aim was to provide opportunities for experiences which included travel to be observed. Observation sessions which involve travelling with someone and discussing the impact of geographical factors on the phenomena of interest are similar to ‘go-along interviews’, a method which can be useful in understanding “how physical, social, and mental dimensions of place and space interact within and across time for individuals” (Carpiano, 2009, p.264).

3.10 Chapter summary

This chapter has provided an outline of the theory which underpins the research, and discussed specific issues related to the methods employed. The meta-theoretical position is critical realism, in which observation is limited to the empirical realm, and epistemic activity involves the generation of theories to explain such observations. This allows for both qualitative and quantitative methods, and for the integration of findings from both. Allowing for multiple theories to overlap and coexist means that the middle and micro-range theories described in this chapter can be applied to different aspects of the enquiry.

In the following chapter, a more straightforward description of the methods employed is provided.

Chapter 4. Methods

4.1 Introduction

The preceding chapter provides the theoretical framework which grounds this research and addresses specific issues relating to the methodological approach. The purpose of this chapter is to outline the methods employed across the three phases of the thesis. It will also describe the important role played by the many patient and public advisors who provided consultation and advice throughout the course of the PhD.

4.2 Mixed-methods sequential approach and triangulation of findings

The three phases of the research were sequential-: (1) a mixed-methods systematic review, (2) a cross-sectional study of ED attenders, and (3) a focussed ethnography exploring treatment burden for people with multimorbidity and palliative conditions. The findings of phase 1 informed the approach of phases 2 and 3, and the findings of phase 2 informed phase 3. Figure **4-1** provides a summary of this process and how it relates to three broad areas of enquiry.

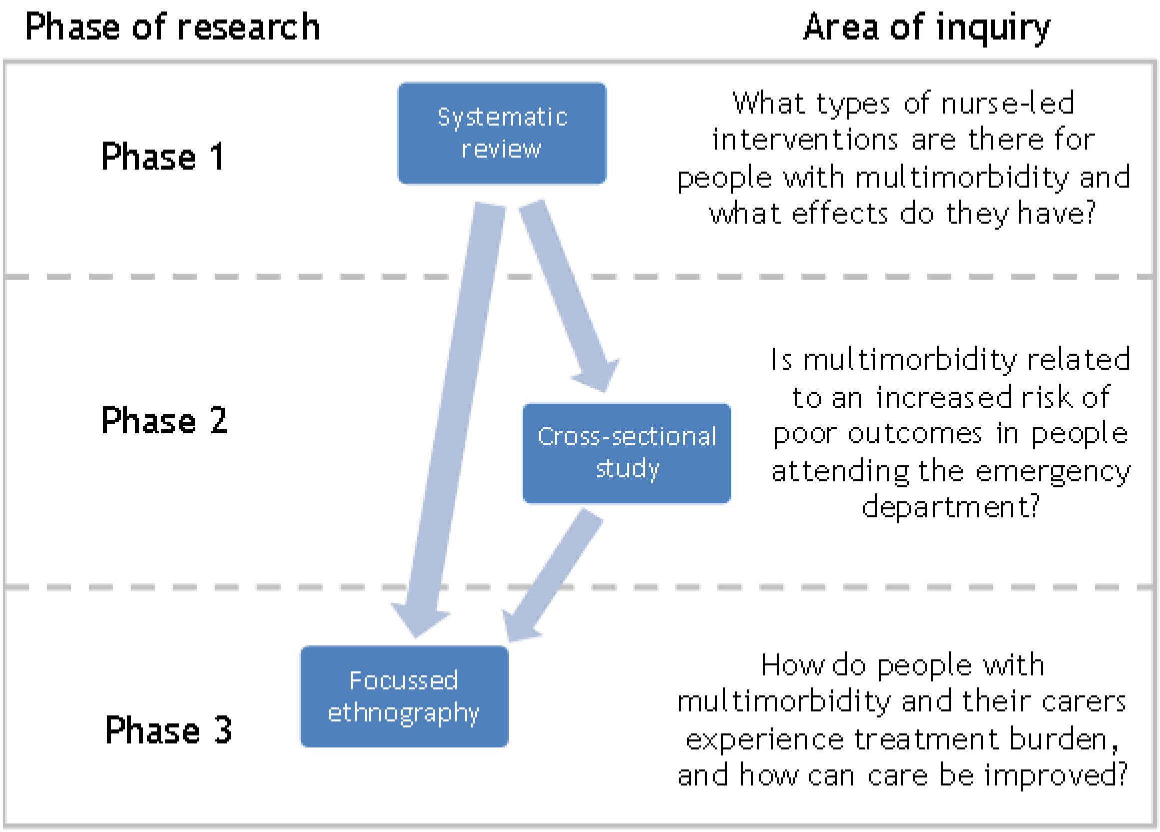


Figure 4-1: Summary of research programme

4.3 Patient and public involvement (PPI)

Involving patients and members of the public at various stages in the research process is considered good practice (Biddle et al., 2021; Greenhalgh et al., 2019). The National Institute for Health and Care Research (NIHR) outline some of the reasons why researchers may consider doing PPI, including:

- The democratic principle that people who will be affected by the outcome of research should have a say in how it is conducted.
- Providing a distinct perspective which incorporates their lived experiences and membership of any relevant groups/communities.
- Improving the quality of research by focussing on outcomes which matter to patients and ensuring recruitment strategies will work with specific patient groups.

- Improving the relevance of research by guiding researchers towards topics/symptoms/conditions etc which are more important to patients.

- Demonstrating to potential funders that PPI has been incorporated into potential projects (increasingly expected).

- Demonstrating to ethical review boards that PPI has been incorporated into potential projects (also expected) (NIHR, 2021)

This project was undertaken with support from one permanent PPI consultant. During the qualitative phase, when it was particularly important to ensure the materials and methods were accessible to a wide range of individuals, a larger PPI group was convened.

4.3.1 Primary consultant: Annabelle

Annabelle has been a PPI consultant for the duration of the research outlined in this thesis. In summer 2020, Annabelle responded to a call for participants in the project and has uniquely been available to the project ever since. This is primarily because of her fit with the research subject profile, but additionally because of her knowledge of and insight into health research having spent 10 years working in the NHS, and nearly 30 years as an academic in this field.

While not a clinical professional she has a wealth of experience, both working in and dealing with the NHS in a personal and professional capacity. Furthermore, as she was isolating during the COVID pandemic, contact has been exclusively virtual, but this context has provided invaluable insight into how people with multiple conditions were interacting with healthcare services, and how their post-lockdown experiences continued to be determined by the restrictions imposed during that period. This helped shape some of the inquiry in the final qualitative phase of the research, while the project remained at all times the thesis authors own work.

With approval from the thesis supervisory team, Annabelle’s background allowed her to provide informal feedback on some aspects of the research and provided the benefit of discussion with someone with the lived experience of multimorbidity in healthcare, which has been of great value throughout the process.

4.3.2 The EMBARQUE PPI group

The primary consultant reviewed documentation throughout the PhD, but for the final study it was anticipated that participants may have complex communication needs and come from a range of different backgrounds. In order to secure a diverse range of opinions and experiences, an 11-person PPI group was convened who represented a broad range of chronic conditions and disabilities including Addison's disease, asthma, blindness, bronchiectasis, cardiovascular disease, chronic anxiety, chronic pain, deafness, dementia, demyelinating neurological disorder, depression, diabetes, Ehlers-Danlos syndrome, epilepsy, hyperaldosteronism, hypercholesterolaemia, hypertension, immunodeficiency, impaired mobility, inflammatory arthritis, Marfan syndrome, osteoporosis, peripheral vascular disease, and stroke.

The group reviewed and commented on all documentation and provided feedback on the overall methodology. As a result, several measures were taken to ensure that people with cognitive impairment and people with deafness or blindness were still able to participate in the research. These included the availability of large and giant-print versions of all documentation, the ability to record (rather than write) information, the ability to provide consent with a witness, and the availability of documentation optimised for electronic reading software. While this took several weeks to coordinate, it ensured that people were not inadvertently excluded from the study due to illness or disability.

4.4 Phase one – A mixed-methods systematic review of nurse-led interventions for people with multimorbidity

The first phase of this research sought to explore the different types of nurse-led interventions for multimorbidity, and to establish the ways in which they were beneficial.

4.4.1 Study design

In order to address these aims, a mixed-methods systematic review using a convergent-integrated approach was conducted, following the Joanna Briggs Institute (JBI) methods (Lizarondo et al., 2020). The protocol was registered on the international prospective register of systematic reviews (PROSPERO) in October 2020 and amended in March 2021 to reflect changes to eligibility criteria. The JBI approach was adopted owing to the fact that it provided a comprehensive methodology for mixed-methods evidence synthesis, including specific tools for data extraction and quality appraisal.

In keeping with the meta-theoretical position of the thesis as a whole, mixed methods systematic reviews using the JBI approach allows the reviewer to engage with both quantifiable tests of effectiveness and more interpretive accounts of phenomena. Or as the JBI handbook argues:

> Through the development of a well-structured [mixed-methods systematic review], the numerical data inherent in the positivist paradigm can support or endorse the equally important opinions and perspectives presented in interpretive and critical paradigms and vice versa. This has the potential to produce more informative conclusions than those derived from evidence presented in autonomous modes of synthesis, i.e. effectiveness systematic reviews and experiential systematic reviews (Lizarondo et al., 2020, p. 271)

The JBI mixed-methods approach always involves qualitative and quantitative results being synthesised (i.e. a convergent approach), but there are two ways of doing this. One option involves qualitative and quantitative data being analysed separately before the two complementary syntheses are integrated (a convergent segregated approach), while another approach involves integrating the results of qualitative and quantitative studies during the analytical phase (a convergent integrated approach). As stated earlier, this phase of the thesis adopts the latter approach.

The review was also designed and conducted in accordance with the guidance provided by the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) (Page et al., 2021). The PRISMA checklist is in Appendix 2. The review was completed in April 2022 and published in the Journal of Advanced

Nursing in September 2022 (McParland et al., 2022b). The published paper is in Appendix 3.

The decision to adopt the approach outlined here was driven by the research aims and objectives. The primary aim was:

1. To identify what types of nurse-led interventions are effective in improving outcomes for people with multimorbidity.

This overarching aim was further divided into two specific objectives:

a. To identify and categorise the different types of nurse-led interventions for people with multimorbidity, and

b. To identify which outcomes are improved by nurse-led interventions for people with multimorbidity.

From initial scoping of the literature, the conclusion was reached that attempting to address either of these objectives without consulting both qualitative and quantitative research would be inadequate. In the case of (a), interventions are described in both qualitative and quantitative studies, and both qualitative and quantitative evaluations could address objective (b).

A convergent-integrated approach is taken when both types of evidence can address the research questions, rather than when different aspects of the question can be addressed by different types of evidence (a convergent-segregated approach) (Stern et al., 2020). Figure 4-2 outlines the difference between these approaches. More information on how data were synthesised and integrated can be found later in this chapter (page 93).

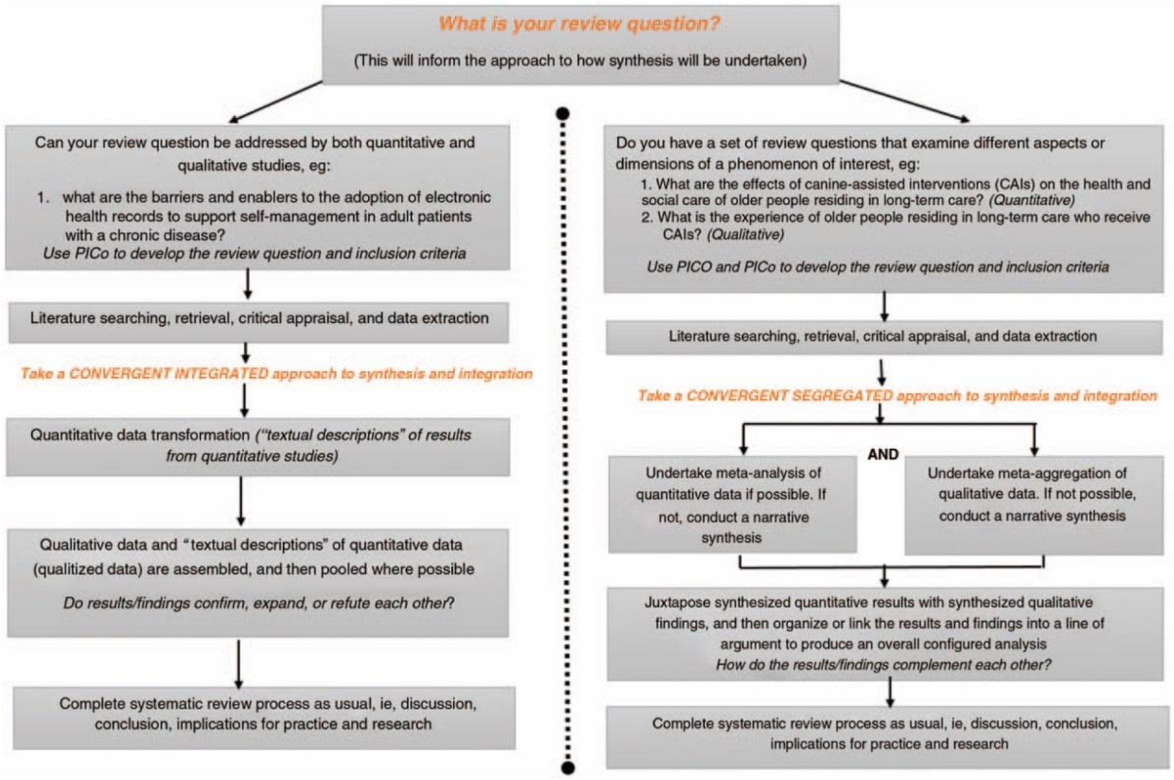


Figure 4-2: JBI approach for mixed-methods systematic reviews. Reproduced from Stern et al. (2020)

4.4.2 Data sources

Data were sourced from a combination of structured database searching and grey literature searches.

4.4.2.1 Databases

Four healthcare databases spanning nursing, medicine, life sciences and biomedicine were searched: MEDLINE, Embase, CINAHL and Cochrane CENTRAL.

It is recommended that systematic reviews search several overlapping databases to limit the possibility of missing relevant publications (Bramer et al., 2017). The JBI guidance on data sources recommends MEDLINE and Embase, with the addition of CINAHL for nursing research (Aromataris and Riitano, 2014).

4.4.2.2 Grey literature and hand searching

In addition to the structured database searches, grey and unpublished literature was sought, as were potentially-relevant peer-reviewed reports not identified during the systematic database searches. Both the Cochrane Handbook for

Systematic Reviews (Higgins et al., 2022) and the JBI Manual for Evidence Synthesis (Aromataris and Munn, 2020) recommend searching for grey literature as there is a bias towards the publication of positive results which may skew the findings of evidence syntheses (Ahmed et al., 2012). Grey literature can help identify relevant studies which do not report positive effects.

Open Grey is a repository of grey literature including theses, unpublished research reports and conference papers. It does not make use of a controlled vocabulary and is only searchable using Boolean operators (such as AND, OR, NOT). Open Grey was searched using the methods detailed in the following section.

The Journal of Multimorbidity and Comorbidity (formerly the Journal of Comorbidity) was also searched from its inception by hand, in order to ensure that relevant peer-reviewed research not indexed in the databases listed above was retrieved.

4.4.3 Search strategy

4.4.3.1 Databases

MEDLINE, Embase, CINAHL and Cochrane CENTRAL were searched from their inception to the 29th of October 2020. A combination of subject headings and title/abstract keyword searches were employed. Combinations of synonyms for multimorbidity and related terms were combined with synonyms and similar terms for nurse-led care using the ‘AND’ operator. An example of the terms used is presented in Table 4-1 below.

A recent systematic review and meta-analysis of multimorbidity and quality of life by Makovski et al. (2019) used a comprehensive list of multimorbidity synonyms which were employed here. Synonyms for nurse-led care were identified through literature scoping and based on the more comprehensive nursing-specific subject headings available in CINAHL.

No search limitations were placed on date, language or full-text availability. An example of the full search strategy for MEDLINE can be found in Appendix 4.

Multimorbidity terms	Nurse-led care terms
Multimorbidity	nurse led
multi-morbidity	nurse-led
multi morbidity	nurse managed
multimorbidities	nurse-managed
multi-morbidities	nurse based intervention
multi morbidities	nurse-based intervention
multimorbid	primary nurse
multi-morbid	primary nurses
multi morbid	primary nursing
comorbidity	nurse practitioner
co-morbidity	nurse practitioners
co morbidity	practitioner nurse
comorbidities	practitioner nurses
co-morbidities	advanced practice nurse
co morbidities	advanced practice nurses
comorbid	advanced practice nursing
co-morbid	nurse specialist
co morbid	nurse specialists
multiple chronic conditions	specialist nurse
multiple chronic illnesses	specialist nurses
multiple chronic diseases	specialist nursing
multiple conditions	nurse clinician
multiple illnesses	nurse clinicians
multiple diseases	nurse consultant
multiple diagnoses	nurse consultants
morbidity pattern	consultant nurse
morbidity patterns	consultant nurses
polymorbidity	case manager **AND** (nurse **OR** nurses **OR** nursing)
poly-morbidity	case-manager **AND** (nurse **OR** nurses **OR** nursing)
poly morbidity	case management **AND** (nurse **OR** nurses **OR** nursing)
Polymorbidities	case-management **AND** (nurse **OR** nurses **OR** nursing)
poly-morbidities	
poly morbidities	
polypathology	
poly-pathology	
poly pathology	
polypathologies	
poly-pathologies	
poly pathologies	
pluripathology	
pluri-pathology	
pluri pathology	
multipathology	
multi-pathology	
multi pathology	
multipathologies	
multi-pathologies	
multi pathologies	
multiple pathologies	
disease cluster	
disease clusters	

Table 4-1: Systematic review search terms

4.4.4 Eligibility

4.4.4.1 Publication type

Any peer-reviewed scholarly research published in English was considered eligible for inclusion. This included journal articles, academic theses and published research reports. Conference abstracts and research letters were only considered if an associated publication with sufficient detail could be identified.

4.4.4.2 Study design

Any primary research study employing qualitative, quantitative or mixed methods was considered eligible for inclusion. Secondary sources such as literature reviews were excluded.

4.4.4.3 Participants

Participants were required to be adults aged 18 or over. There was no upper limitation on age, nor restrictions on sex, ethnicity or gender. Participants were required to have multimorbidity.

In the context of this review, multimorbidity was defined as the coexistence of two or more chronic conditions, where one condition is not held to be more important than the others. 'Conditions' in this case are not restricted to formally diagnosed chronic diseases and can include biopsychosocial and somatic risk factors. This definition is based on the work of Boyd and Fortin (2010) and Le Reste et al. (2013). Care was also taken to differentiate multimorbidity (as defined by van den Akker et al. (1996)) from comorbidity (as defined by Feinstein (1970)), in that interventions which required the presence of a specific ‘index condition’ plus comorbidities or were only targeted at limited clusters of conditions were not included. Combined physical and mental health morbidity was accepted, but mental health comorbidity in the absence of any physical conditions was not. Additionally, studies in which multimorbidity was assumed to be present based solely on the presence of advanced age or frailty in the target population were also excluded.

4.4.4.4 Intervention

Eligible studies were those which detailed a nurse-led intervention. Initial scoping identified that nurse-led interventions were often poorly defined in the literature. Three key indicators were identified during these searches which would highlight the possibility that an intervention was nurse-led. These definitions were agreed between the thesis author and supervisory team, and the presence of any of these three factors was deemed sufficient to merit consideration. These indicators of nurse-led care were as follows:

1. Care is delivered by nurses as part of a service that is led by a (possibly consultant) nurse or nurses. For example, inpatient Primary Nursing interventions which emerged in the 1980s in the UK (see Pearson (1988)).

2. Nurses manage and are accountable to a case load of patients. For example, nurse case managers and community matrons in England and Wales during the early-to-mid 2000s (see Shilpa Ross et al. (2011)).

3. Nurses practice with a discernible degree of autonomy compared to nurses delivering physician-led care. This may include advanced clinical skills, direct referral and discharge mechanisms, the ability to initiate diagnostic tests and prescribe medications, and increased autonomy and scope for decision making, all of which are common features of nurse-led clinics (Richardson and Cunliffe, 2003).

4.4.4.5 Setting

There were no restrictions based on setting, both geographically and in terms of care-facility. Studies from any country based in primary care, secondary care or any other setting were considered eligible for inclusion.

A summary of the inclusion and exclusion criteria can be found in Table 4-2.

Category	Inclusion criteria	Exclusion criteria
Publication type	• English language publications • Peer-reviewed scholarly research publications • Academic theses • Published research reports	• Non-English publications • Anecdotal reports • Unsupported research letters or conference abstracts
Study design	• Primary research studies reporting qualitative, quantitative or mixed-methods	• Secondary research reports (i.e. literature reviews)
Participants	• Adults aged 18 or above • People with multimorbidity including at least one physical health condition	• People aged under 18 • People with mental-health only multimorbidity/ comorbidity • People with an index condition and associated comorbidities
Intervention	• Interventions which are led at service-level by a (possibly consultant) nurse or nurses. • Interventions where a nurse is accountable to a case-load of patients • Interventions where nurses practice with a discernible degree of autonomy compared to when delivering medically-led care	• Interventions led by health care practitioners other than nurses
Setting	• Studies set in any geographical location/country • Interventions set in primary care, secondary care or any healthcare setting	

Table 4-2: Systematic review inclusion/exclusion criteria

4.4.5 Screening

4.4.5.1 Deduplication

All citations were imported into Endnote citation management software (The EndNote Team, 2013). Computer-assisted detection of duplicates (requiring manual confirmation of each decision by the reviewer) was conducted within Endnote. Manual detection and deduplication was also conducted.

4.4.5.2 Title/abstract screening

Deduplicated citations were exported from Endnote to Rayyan QCRI, a web-based application designed for citation screening (Ouzzani et al., 2016). Rayyan was used to manage citations and log decisions, titles and abstracts were read manually. The thesis author screened all abstracts against the predetermined inclusion/exclusion criteria listed above. Regular meetings were held with the supervisory team to discuss any emergent issues around eligibility.

4.4.5.3 Full-text screening

All screened citations were exported from Rayyan QCRI back to Endnote. Articles which met the eligibility criteria were retrieved in full. All were read by one reviewer with verification from a second. Approximately 25% of papers were reviewed independently by a second reviewer, and disagreements were resolved in discussion with a third reviewer.

4.4.6 Quality appraisal

The JBI tools for quality appraisal were used. These are freely available and include tools for the appraisal of RCTs, quasi-experimental studies (Tufanaru et al., 2020), cohort studies (Moola et al., 2020), and qualitative studies (Lockwood et al., 2015) amongst others.

In quantitative systematic reviews, critical appraisal is an essential step in the review process as it allows studies with a high risk of bias to be excluded from the synthesis. Often the aim of such reviews is to reach a quantifiable assessment of the effectiveness of a given intervention, so it is important to also quantify the extent to which recommendations made are free from bias (Boutron et al., 2022). The Grades of Recommendation, Assessment, Development and Evaluation (GRADE) approach is the most commonly-used method of assessing the quality or certainty of a body of evidence, and is recommended by Cochrane for the assessment of important outcomes in quantitative reviews of effectiveness (Schünemann et al., 2022). However, due to the complexities of integrating qualitative and quantitative evidence and the impact of transforming data to allow for this, the JBI approach does not recommend the use of GRADE (Lizarondo et al., 2020). There are several JBI tools for critical appraisal of quantitative studies which have been used here, and which are deemed suitable for use in mixed-methods reviews.

Assessing the quality of qualitative research is less straightforward, raising as it does issues around epistemology, ontology, and conflict between mutually-exclusive assumptions around the nature and creation of knowledge (Porritt et al., 2014). Attempts to develop overarching criteria which apply to all qualitative research in spite of these differences have been made, while others have sought to develop different criteria for the major approaches (narrative, phenomenological and ethnographic enquiry, grounded theory and case study research (Creswell, 2017; Tracy, 2010)). Including all types of qualitative research in the review necessitates the adoption of the former approach. The JBI tool for assessing the quality of qualitative research is appropriate for this purpose, focussing as it does on congruence between aspects of study design, namely epistemology and theory, theory and methodology, and methodology and methods (Porritt et al., 2014). Similar to GRADE, the ConQual approach is used to assign levels of confidence to synthesised qualitative findings (Munn et al., 2014), however it is also not recommended by JBI for use in mixed-methods systematic reviews (Lizarondo et al., 2020).

The rationale for adopting the JBI tools is largely based on the heterogeneity of the information sources and the need to integrate both qualitative and quantitative evidence. The argument in support of the quantitative tools is straightforward, in that they require studies to meet external standards of quality similar to those required by other appraisal tools such as adequate blinding and follow-up, uniform outcome assessment, or appropriate statistical methods (Tufanaru et al., 2020). With regards to the qualitative tools, their usefulness relates more to their suitability in the context of a mixed methods review which aims to produce recommendations. In contrast with other approaches to qualitative synthesis such as meta ethnography, the JBI approach is meta-aggregative, seeking to develop more generalisable statements or guidance which is useful to practitioners (Lizarondo et al., 2020). The qualitative quality appraisal tools therefore focus mainly on the internal congruity of the studies, rather than their ability to satisfy external thresholds of quality (Lockwood et al., 2015). All appraisal tools have accompanying guidance which is designed to help the reviewer decide whether criteria have been satisfied.

All studies were appraised independently by two reviewers. Disagreements were logged and shared between all three members of the study team. Meetings were held to discuss disagreements and resolutions were reached with the mediation of the third researcher who had not appraised the study.

As well as reporting quality scores in full as recommended by the JBI guidance (Lizarondo et al., 2020), a summary quality score was calculated. This score was the percentage of outcomes satisfied in each appraisal checklist. This was not intended to facilitate comparisons between different study designs, but rather to provide a synopsis of the overall quality of the study.

It was decided in advance not to exclude any studies based purely on methodological quality, but to conduct sensitivity analyses to determine whether studies with low scores (<50%) added novel findings.

4.4.7 Data extraction and transformation

The following data were extracted from each study report: citation, methodology, participant details, intervention details, setting, outcomes affected, and authors' conclusions. Background papers were consulted where necessary (particularly for details of interventions), and all data were extracted using the standardised JBI data extraction tool in appendix 8.1 of the JBI evidence synthesis manual (Lizarondo et al., 2020).

Qualitative data were extracted at the level of themes, subthemes and any distinct thematic concepts which were illustrated by direct quotations. Extracted findings were ascribed a level of credibility dependant on the extent to which they were reflected by attached quotations. As recommended in the JBI guidance (Lizarondo et al., 2020), findings were rated as either unequivocal (i.e. beyond doubt or matter-of-fact observations), credible (i.e. plausible interpretations), or unsupported (where data did not support the interpretation).

For quantitative findings, the threshold of significance was established at $p<0.05$ but any reported effect-size measurement was considered (such as odds ratios (ORs), adjusted odds ratios (aORs), and 95% confidence intervals (95% Cis)). In order to prepare quantitative data for integration with qualitative findings, the statistical information must be ‘qualitised’, or transformed into qualitative data which provides a narrative response to the research question (Lizarondo et al., 2020).

All extracted data were saved as Microsoft Word documents and imported to Nvivo qualitative data analysis software (QSR International Pty Ltd, 2020) in preparation for synthesis.

4.4.8 Data synthesis

Data were synthesised by grouping together qualitative and ‘qualitised’ quantitative findings by similarity in order to arrive at conclusions. Two existing frameworks (one for interventions and another for outcomes) were applied to the data, before being adapted and added-to through inductive coding.

The EPOC taxonomy of interventions (EPOC, 2015) is widely used to categorise healthcare interventions, including in the most recent Cochrane systematic review of multimorbidity interventions in primary care (Smith et al., 2021). The decision was taken to apply this framework at two levels: intervention components, and the overall intervention type. Intervention components were defined as any described aspect of an intervention which differs from usual care.

In order to provide a succinct description of interventions and to allow them to be grouped together by broad categories, they were also classified at the level of overall intervention type. Intervention type was defined as the intervention component which most accurately describes the whole intervention in a way that differentiates it from usual care.

To categorise outcomes, the Core Outcome Set for Multimorbidity Research (COSmm) was applied to extracted data (Smith et al., 2018). The COSmm is an expert consensus-developed set of seventeen core outcomes which are important to multimorbidity research. For many outcomes, specific outcome measures are recommended (e.g. EuroQol 5-Dimension (ED-5D) for health-related quality of life) meaning that findings can be reliably mapped to outcomes across different studies. In addition to the COSmm, inductive coding of effects was conducted to capture any impact on outcomes not included in the COSmm. Effects were classified as positive, negative or unaffected. For the integration of multiple studies measuring the same effect on an outcome, the overall impact was classed as either ‘mostly improved’, ‘mixed’ or ‘mostly unaffected’.

Early scoping of the literature indicated a high degree of heterogeneity with regards to intervention type, study populations and the types of conditions considered. It was therefore recognised that meta-analysis was unlikely to be an option.

4.4.9 Updating the systematic review

During the final preparation of the thesis in June 2023, the above process was repeated in order to capture any reports published in the intervening period. In the next chapter, the screening process for the updated review is presented separately to the original review; however, the findings are synthesised. Any notable changes between the original publication (McParland et al., 2022b) and the updated review are highlighted at the end of that chapter.

4.5 Phase two – The association between multimorbidity and negative outcomes in ED attenders: the cross-sectional study

4.5.1 Introduction

The second phase of this research sought to establish whether multimorbidity and disease-burden were significant factors in predicting poor outcomes in people attending the ED. The project made use of routinely-collected healthcare data, and was a secondary analysis of an existing data extract. The study is reported in line with the RECORD guidance (Benchimol et al., 2015); see Appendix 1. Ethical approval was granted by NHSGGC Safe Haven LPAC (see Appendix 5) in September 2021, and the findings were published in the Journal of Multimorbidity and Comorbidity the following year (McParland et al., 2022a). The published paper is in Appendix 6.

Two a priori hypotheses were developed (1 and 2), alongside a third (3) which was suggested a posteriori during the publication's peer-review process:

1. There will be a positive association between multimorbidity and:
    a. Admission to hospital
    b. 30-day reattendance at the emergency department
    c. 90-day reattendance at the emergency department
    d. Mortality during admission.

2. The risk of admission to hospital, 30- and 90-day reattendance at the emergency department, and mortality during admission will increase with the number of chronic conditions a person has.

3. There will be a positive association between complex multimorbidity and:
    a. Admission to hospital
    b. 30-day reattendance at the emergency department
    c. 90-day reattendance at the emergency department
    d. Mortality during admission.

In the context of this study, multimorbidity is defined as the presence of two or more concurrent chronic conditions, and complex multimorbidity as the presence of three or more concurrent chronic conditions affecting three or more body systems. Methods for the identification of these exposures are detailed later in this chapter (page 108).

4.5.2 Study design

The study employed a cross-sectional design with a 12-month study period. For people attending the emergency department more than once during the period, the first attendance was treated as the index attendance. The decision to use a 12-month period was taken to reduce the potentially-confounding effects of seasonal variations in ED performance and the aetiology of attendances.

4.5.3 Setting

The physical setting of this research is within the NHSGGC health board, Scotland. The cohorts and de-identified linked data used in this study were prepared by the West of Scotland Safe Haven at NHS Greater Glasgow and Clyde.

4.5.4 Description of datasets used for the secondary analysis

The following sections provide a short summary of the data extracts available for the study.

It is also important to note that the data available was only for people resident in the Glasgow city area, and not the whole Greater Glasgow and Clyde health board.

Healthcare data in Scotland is linked through an identification number, the Community Hospital Index (CHI) number. As part of the de-identification process, this is replaced by a Safe Haven ID in data extracts made available to researchers using the Safe Haven platform.

4.5.4.1 Emergency department dataset

The emergency department dataset contains records for all attendances at emergency departments, nurse-led minor injury units, specialist assessment and treatment areas (SATAs) which were set up during the COVID-19 pandemic, immediate assessment units, and any other such units which provide unscheduled secondary care. Attendances were available between 1st July 2017 and 30th June 2020.

4.5.4.2 Scottish Morbidity Record: general/acute inpatient and day case records (SMR01)

SMR01 records are generated for patients being treated in general and acute care settings. Each record does not represent a new admission; therefore, a patient will often generate multiple SMR01 records during a stay in hospital. The SMR01 Summary of Rules in the National Data Catalogue (Information Services Division Scotland) states that the following events will result in the generation of a new SMR01 record:

1. Inpatients and day cases are admitted to NHS hospitals from locations external to the NHS.

2. Inpatients and day cases are admitted to contracted NHS beds in non-NHS institutions.

3. Inpatients and day cases change specialty (with or without a change of consultant) when:

    a. An Inpatient transfers to become an Inpatient in another specialty in the same hospital.

    b. An inpatient becomes a Day Case in another specialty during the inpatient stay.

    c. A day case transfers to become an Inpatient in another specialty (except when the day case episode is during an inpatient stay and the patient is transferring back to the original consultant).

    d. A day case transfers back to resume an Inpatient stay but does NOT transfer back to the original consultant for medical reasons.

4. Inpatients and day cases transfer from another NHS hospital (including contracted NHS beds in non-NHS institutions).

5. Inpatients and day cases change consultant for medical reasons within the same specialty when:

    a. An inpatient transfers as an Inpatient to the care of a different consultant for medical reasons in the same specialty in the same hospital.

    b. An inpatient becomes a Day Case in the same specialty under a different consultant for medical reasons during the inpatient stay.

    c. A day case transfers to become an Inpatient under the care of a different consultant in the same specialty for medical reasons (except when the day case episode is during an inpatient stay and the patient is transferring back to the original consultant).

  d. A day case transfers back to resume an Inpatient stay in the same specialty but does NOT transfer back to the original consultant for medical reasons.

6. Inpatients move into and/or out of one of the valid significant facilities.

7. Inpatients return to hospital having been on pass for more than 5 days.

Important to this analysis, SMR databases (and all Scottish secondary care datasets) make use of two standardised coding schemes: ICD-10 for diagnoses, and the Office of Population Censuses and Surveys, Fourth Revision (OPCS-4) for procedures and interventions.

SMR01 data were available between 1st July 2017 and 30th June 2020.

4.5.4.3 Demographics and ethnicity

Some demographic information is available in other datasets, however there is also a data extract which contains demographic information for all patients present in other extracts (i.e., those attendances contained in the emergency department dataset). Demographics included in this database are: date of birth, sex, post code area, as well as Scottish Index of Multiple Deprivation (SIMD) data. SIMD is a relative measure of deprivation in which Scotland is divided into 6,976 zones ranked 1-6,976 dependant on relative levels of deprivation (1 being the most deprived and 6,976 being the least deprived). Relative deprivation is calculated based on seven domains: income, employment, education, health, access to services, crime, and housing (The Scottish Government, 2020). SIMD data is often analysed in strata, either deciles (least deprived 10% to most deprived 10%) or quintiles (least deprived 20% to most deprived 20%).

Ethnicity data follows a standardised coding system, in which the following seven categories are used: White, Mixed or multiple ethnic groups, Asian, African, Caribbean or Black, Other ethnic group, or Not Known. More granular information is also available.

4.5.4.4 Mortality

National Records of Scotland (NRS) collate data on a weekly basis for all deaths in Scotland (i.e. not just in-hospital mortality). The data extract for mortality extended to August 2021, ensuring more than 12 months follow-up mortality data was available for those attending ED at the end of the study period.

4.5.4.5 Other datasets not used in secondary analysis

Several other datasets were available, the majority of which did not contain data required for the analyses outlined. One contained laboratory results for all patients in the dataset between 1st July 2017 and 30th June 2020, but as will be discussed later, it was not possible to use this information due to the way results were reported.

4.5.5 Information sources

A key factor which can mediate the strength of conclusions drawn from research using routinely-collected data is the accuracy of the data. It is important then to outline how this information flows from the clinical setting to the Safe Haven.

Mortality data is drawn from a variety of sources including death certificates and NHS data, and is collated by National Records of Scotland on a weekly basis. Demographic data is similarly drawn from a variety of sources and linked through CHI.

All fields in the emergency department dataset are entered by staff in the emergency department, including administrative staff (e.g. basic patient identifiers/CHI, time of attendance), nurses (e.g. clinical observations, triage details, discharge type) and medical staff (e.g. discharge diagnoses). These discharge diagnoses were not used in the analysis, primarily due to their use of a different coding methodology (Emergency Care Data Set/ECDS).

The information flow of SMR data is slightly more complex. In the clinical setting, doctors will complete a discharge summary and also a letter for the patient’s GP. Both of these documents will be viewed by a coder at a later date, who will then create an SMR record using SMR data standards including ICD-10.

Importantly, the coder may not have access to the full record of the patient, therefore the quality of the SMR data is highly dependent on the quality of the discharge information provided by the doctor in the clinical setting.

4.5.6 Participants

Any adult from the Glasgow city area attending any ED in NHSGGC between 1st April 2019 and 31st March 2020 were included in the sample.

The date-range was determined based on three criteria. Firstly, a 12-month period was sought to capture seasonal variations. Secondly, a three month follow-up period was required for ED reattendance. Finally, an extended follow-up period to capture inpatient mortality was required for anyone admitted for an extended period.

Anyone aged 16 or over was considered to be an adult.

The definition of an emergency department included immediate assessment units, SATAs, and any other acute assessment unit where unscheduled care is provided and where clinicians can admit patients to hospital. Nurse-led minor injury units were excluded, as these do not deal with illnesses and clinical staff cannot directly admit to hospital. In the event that someone attends a minor injury unit and requires medical assessment or admission, they would be referred to an emergency department and would therefore be included in the sample.

4.5.7 Variables

In order to satisfy statistical assumptions of independence, it was necessary to ensure that individuals with multiple attendances were only counted once. For this purpose, an individual's first attendance during the study period was considered to be the index attendance which all outcome, exposure and confounder variables were derived from.

4.5.7.1 Outcome variables

All outcome variables were considered co-primary. Admission to hospital is a mandatory coding item in emergency department data. Cases were coded for 30- and 90- day reattendance if a new emergency department attendance was recorded within these time periods of the index attendance. In order to avoid artificial inflation of these figures, same-day reattendances which occurred within the data were removed. Causes for this may include where someone is called back to the ED by the treating clinician, where someone is referred to another facility, or when someone is transferred from one ED to another for treatment which is only available at a particular site.

Mortality and inpatient records were linked to emergency records by pseudonymised identifiers (Safe Haven ID), and mortality at the various timepoints was calculated with reference to the ED index attendance. Standardised discharge coding allowed identification of whether an SMR01 record had been generated due to a planned transfer and whether a new one was to be expected due to being transferred out. Inpatient mortality was thus identified by linking inpatient and emergency department records to establish continuous inpatient ‘episodes’ from attendance to discharge, and cross-referencing date-of-death with these admission episodes.

4.5.7.2 Exposure variables

Chronic conditions were identified using adapted algorithms which utilise ICD-10 codes and have been validated to detect the conditions with moderate to high reliability, in a large Canadian cohort by Tonelli et al. (2019). The thirty algorithms were based on an original group of forty conditions determined to be of importance in multimorbidity research, and which were used in a landmark epidemiology of multimorbidity in Scotland published in the Lancet by Barnett et al. (2012). The algorithms deployed by Tonelli et al. (2016) were further refined in a recent study of secondary care patients in England by Stokes et al. (2021), in which the authors collapsed three cancer diagnoses (lymphoma, metastatic and non-metastatic) into a single diagnosis for cancer. These 28 algorithms then underwent minor adjustments to ensure compatibility with NHS Scotland coding standards. A summary of these changes is detailed in Table 4-3.

Condition	Changes required to ensure compatibility with NHS Scotland data
Chronic kidney disease	Laboratory inclusion alongside ICD-10 codes (mean eGFR <60 mL/min*1.73 m2 or mean albuminuria >30 mg/g over 12 months) in original algorithms. Results were not reported in a manner compatible with the algorithm, therefore only ICD-10 codes were used.
Chronic pain	In a published erratum, Tonelli et al. (2019) added three additional ICD-10 codes: G89.0, G89.2 and G89.4. These codes are not used in NHS Scotland (or the original Canadian) data.
Epilepsy Myocardial Infarction Stroke or TIA	These conditions required identification of the most-responsible reason for admission. The first-entered ICD-10 code in SMR data is mandatory and likely represents the main reason for admission, therefore searches for these conditions were limited to the first-entered ICD-10 code.
Irritable bowel syndrome Severe constipation	Surgical exclusions for these conditions were validated using CCPx codes which are not used in NHS Scotland. Equivalent exclusions were identified using OPCS-4 codes. **For severe constipation:** K63.81 and K63.88 are not used in NHS Scotland data. K63.8 (OTHER SPECIFIED DISEASES OF INTESTINE) was used in their place. K92.80 and K92.88 are not used in NHS Scotland data. K92.8 (OTHER SPECIFIED DISEASES OF DIGESTIVE SYSTEM) was used in their place. These accounted for <5 detected cases of severe constipation.

Table 4-3: Changes made to original algorithms to ensure compatibility with NHS Scotland data

A complete list of the algorithms and exclusions is in Appendix 7.It is also important to note that the timescales for which detected conditions were considered valid (i.e., five years, two years, permanent) was not relevant in this case. In order to ensure equity in the amount of historical inpatient data available for each patient, the ‘look-back’ period for all was restricted to 21 months, equivalent to what would be available for someone attending on day one of the study period.

Binary categorical variables were created for each condition, and conditions were considered present if they met all the inclusion and none of the exclusion criteria. Another binary categorical variable was created for multimorbidity, which was considered present if two or more of the 28 conditions were present at the time of ED attendance. A further seven-level categorical variable was created for disease-count, which indicated whether 0,1,2,3,4,5, or ≥6 conditions were present at the time of ED attendance.

After the manuscript was submitted for publication, one reviewer requested that the analysis be expanded to explore the association between complex multimorbidity (three or more chronic conditions affecting three or more body systems) and the specified outcomes. ICD-10 chapters were used to represent body systems, a method shown by Harrison et al. (2014) to produce comparable results with other measures, namely the Cumulative Illness Rating Scale (CIRS) and the International Classification of Primary Care version 2 (ICPC-2) chapters. A small number of conditions identified using the algorithms were coded across more than one ICD chapter, requiring a decision to be made regarding which chapter should be considered most representative of the body system affected by the specific condition. Details of these conditions and how they were coded are in Table 4-4 below.

Condition	Coded at the following chapters	Resolution and rationale
Alcohol misuse	Endocrine, nutritional and metabolic diseases Mental and behavioural disorders Diseases of the nervous system Diseases of the circulatory system Diseases of the digestive system Injury, poisoning and certain other consequences of external causes Factors influencing health status and contact with health services	Coded at: **Factors influencing health status and contact with health services** Code Z72.1 (alcohol use – contained in above chapter) determined to be most pertinent diagnosis. Others secondary diseases of other systems related to alcohol misuse.
Chronic pain	Diseases of the musculoskeletal system and connective tissue Mental and behavioural disorders	Coded at: **Diseases of the musculoskeletal system and connective tissue** 38 of the 39 codes associated with the condition were contained in the above chapter.
Chronic pulmonary disease	Diseases of the circulatory system Diseases of the respiratory system	Coded at: **Diseases of the respiratory system** Majority of codes were contained in the respiratory system chapter. Condition managed by respiratory physician.
Dementia	Diseases of the nervous system Mental and behavioural disorders	Coded at: **Diseases of the nervous system** Dementia would have been appropriate in either of these categories as both contain relevant primary diagnoses. However, it was felt that patient perception of dementia as an organic neurological disease was more likely.
Multiple sclerosis	Diseases of the nervous system Diseases of the eye and adnexa	Coded at: **Diseases of the nervous system** Primary diagnosis (G35: multiple sclerosis) contained in this chapter.
Stroke or TIA	Diseases of the nervous system Diseases of the eye and adnexa Diseases of the circulatory system	Coded at: **Diseases of the circulatory system** It would have been appropriate to code this as either neurological or circulatory disease, however, the most pertinent diagnoses related to cerebrovascular disease were located in the circulatory chapter.

Table 4-4: Allocation decisions made for conditions which were coded across multiple ICD-10 chapters

4.5.7.3 Confounder variables

Age, sex, ethnicity and deprivation (SIMD) data were available from the databases listed above, and these were included in all adjusted models. Age was handled as an integer and sex as a binary categorical variable (reference: male).

Ethnicity is recorded in seven top-level categories with more granular information available. The Arabic category was disaggregated from the ‘other ethnicity’ category. As is discussed later, in some analyses there were issues with collinearity owing to relatively low levels of certain ethnicities which required for ethnicity categories to be collapsed to a three-level factor; White, Asian, and all other ethnicities. In both cases, ‘White’ was used as the reference.

SIMD was analysed in deciles as a ten-level categorical variable and the lowest decile (associated with the greatest risk of deprivation) served as reference.

4.5.8 Statistical methods

All analyses were conducted using R statistical programming software, version 4.0.5 (R Core Team, 2021).

4.5.8.1 Logistic regression

Both adjusted and unadjusted binomial logistic regression models were fitted for all outcomes. A binomial distribution is one in which all data belong to one of two binary values, such as whether someone *is* or *is not* admitted to hospital.

The following equation represents a simple logistic regression model as summarised in Field et al. (2012), in which the probability of an event occurring (represented by $P(Y)$) is estimated based on a single exposure variable (represented by X_1):

$$P(Y) = \frac{1}{1 + e^{-(b_0 + b_1 X_{1i})}}$$

In this equation, *e* represents the base of natural logarithms and the coefficients are arranged within the brackets in the same formulation as is found in linear regression, so that there is both a constant (b_0) and coefficient attached to the exposure (b_1). The subscript $_i$ simply denotes the label given to the exposure (it could as easily be $X_{multimorbidity}$ for example) and does not require additional calculation.

Adding additional exposures (or confounders) to this model simply requires that they are added within the bracket with a corresponding coefficient. For example, a logistic regression model with three exposures (or one exposure and two confounders) would be expressed as:

$$P(Y) = \frac{1}{1 + e^{-(b_0 + b_1 X_{1i} + b_2 X_{2i} + b_3 X_{3i})}}$$

In this model, a second exposure (X_{2i}) and its coefficient (b_2) have been added, alongside a third exposure (X_{3i}) and its coefficient (b_3). In this way, models can be built which combine both the study exposures (such as multimorbidity) and confounders (such as age or sex).

4.5.8.2 Odds ratios

For classification problems and predictive modelling, regression models will often be used to calculate the probability of an outcome occurring and express this as a value between 0 and 1, as described above. However, for the purpose of testing hypotheses (as is the case here), the decision was taken to express the results of models using odds ratios (ORs) and 95% confidence intervals (95% CIs). Where models are adjusted to control for confounding variables, adjusted odds ratios (aORs) are presented. When the OR/aOR and the lower value of the 95% CI are greater than 1, the probability of the outcome occurring is considered significant and the null hypothesis is rejected.

The OR is the exponential of the coefficient (or the '*e*' in e^b), and it represents the change in the odds of an outcome occurring when a predictor variable is changed (for example, the difference between the odds of someone being admitted to hospital with and without multimorbidity). R allows coefficients to be extracted from models and exponentiated with ease, however, the OR can also be calculated by dividing the odds of an outcome occurring by the odds of it not occurring. The following equation takes the simple logistic regression equation for calculating the probability of an outcome occurring (*P(Y)*) and divides it by the odds of the same outcome not occurring (by subtracting the value of *P(Y)* from 1):

$$Odds = \frac{P(Y)}{1 - P(Y)}$$

Or to present the calculation in full (including the regression formula from the preceding section):

$$Odds = \frac{(\frac{1}{1 + e^{-(b_0 + b_1 X_{1i})}})}{1 - (\frac{1}{1 + e^{-(b_0 + b_1 X_{1i})}})}$$

4.5.8.3 95% confidence intervals

With regards to odds ratios, a 95% confidence interval provides a range within which it can be reasonably assumed the true odds ratio is likely to fall. The following equation describes how a 95% confidence interval is calculated:

$$X = z(SE) + OR$$

Assuming the odds ratio (*OR*) and standard error (*SE*) of a coefficient is known, the only value required to determine the confidence interval (*X*) is *z*, which represents a point on a normal distribution in which the mean is equal to 0 and a standard deviation is equal to 1. To capture 95% of predicted values it is necessary to establish the upper and lower bounds of the confidence interval, i.e. just under 2 standard deviations (or in this case log-likelihood) from the mean value. These upper and lower bounds for *z* are 1.96 and -1.96 respectively. Therefore, the calculation can be carried out twice (using these values for *z*) to establish the 95% confidence interval.

4.5.8.4 Assessment of model-fit

Various measures of model-fit (i.e., how well the model explains the data) are available. However, when using logistic regression for hypothesis testing these are less important than the effect-size measures above.

In linear regression R^2 is commonly used to assess model-fit, and in logistic regression there are several pseudo-R^2 measures which provide an analogous function. Some of the more commonly-used logistic pseudo-R^2 measures include those proposed by Cox and Snell (1989), Nagelkerke (1991), and Hosmer and Lemeshow (2000). However, the measure outlined by Tjur (2009) is becoming increasingly common and in the absence of consensus on which is best, its simplicity and largely analogous function to linear R^2s marks it out as an appropriate choice (Allison, 2013). The following formula outlines the calculation required to obtain a value for Tjur's R^2(denoted as *D* by the author in the original publication):

$$D = \bar{\bar{\pi}}_1 - \bar{\bar{\pi}}_0$$

In the above, Tjur's R^2 (*D*) is calculated by subtracting the average predicted value for all 0's ($\bar{\bar{\pi}}_0$) from the average predicted value for all 1's ($\bar{\bar{\pi}}_1$) in a binomial logistic regression model. The result is bound between 0 and 1, with values closer to 1 indicating better fit.

The value of Tjur's R^2 is provided alongside all models, however, as stated earlier model-fit is not as important when the purpose of fitting regression models is to test hypotheses.

4.5.9 Data linkage and data cleaning

ED data was extracted from 1st April 2019 to 31st March 2020 and each individual's first attendance was marked as the index attendance. Those attending nurse-led minor injury units and the first attendance for those attending two departments in the same day were removed, as outlined earlier. Binary variables were created for admission and reattendance (at both 30 and 90 days). The Safe Haven ID (a pseudonymised CHI) is required to facilitate linkage, therefore records without a Safe Haven ID were removed.

SMR01 records were included from 1st July 2017 (the earliest date available in the dataset) to the end of the study period. As each admission may generate multiple SMR01 records, admission, discharge and transfer codes and dates were used to chain these into a single record for each continuous period of admission.

ICD-10 and OPCS-4 codes were also collapsed into single fields separated by a hyphen (-). In order to identify conditions, these text strings were searched and cross-referenced with admission dates and ED attendance dates alongside any other criteria (such as surgical exclusions). The following R code provides an example of how this was done:

```
DATA$DEPRESSION <- if_else(
  str_detect(DATA$ICD, "F204|F313|F314|F315|F32|F33|F341|F412|F432")
  & DATA$SMR_ADM_DATE >= (DATA$ED_INDEX_DATE - 640),
  TRUE,
  FALSE)
```

‘`DATA$DEPRESSION`’ creates a new column called ‘`DEPRESSION`’ within the data frame ‘`DATA`’, and the `if_else` function determines that if the first condition (in blue) is met, then the value of `DEPRESSION` for that row should be `TRUE` (in green), and if it is not the value should be `FALSE` (in red). Within the blue condition, the `str_detect` function searches the `ICD` field (described above) for any of the ICD-10 codes within the quotation marks (separated by ‘|’, denoting ‘or’). The remainder of the blue section verifies that the SMR01 records was created within 21 months (640 days) of the ED index attendance. Tonelli et al. (2016) specify two years, however, the lookback period was limited to 21 months to ensure those arriving at the end of the study period did not have access to more historic data.

All datasets were merged with the inpatient record, and those records not relating to a patient with an index ED attendance were discarded. The method by which outcome, confounder and exposure variables is discussed in section 4.5.7 (Variables).

4.5.10 Missing data

Two separate analyses were conducted: one complete case analysis (excluding any cases with missing values) and one analysis with missing values imputed. The results of both analyses were compared, to establish if there were any qualitative differences in effect size, direction of effect, or significance of findings. As outlined in the preceding chapter, the primary method of imputation was by using a random forest classification algorithm (Stekhoven, 2022).

A drawback of random forest algorithms is that they can be computationally expensive compared to other methods of imputation, and when testing the algorithm with sample data this proved to be the case when imputing missing data across several variables. For this reason, it was decided that median, modal or mean imputation (dependant on the type and distribution of data) would be used when missingness was less than ~1% for a particular variable.

4.6 Phase three – A focussed ethnography of multimorbidity, treatment burden and burden for carers using reflexive qualitative methods: the EMBARQUE study

The third and final phase of this research programme is a qualitative study exploring how people with multimorbidity and those who care for them experience treatment burden.

4.6.1 Study design

A focussed ethnographic approach to data collection incorporating interviews, observation sessions and participant-directed journaling. Patients and their carers were recruited from the ED and online. Reflexive thematic analysis was employed to explore the data.

4.6.2 Aims and objectives

This phase of the research has one overarching aim and three underpinning objectives.

4.6.2.1 Aim

To explore the experience of treatment burden for people with multimorbidity and palliative conditions, and their carers.

4.6.2.2 Objectives

- To identify common healthcare tasks and responsibilities which are perceived as burdensome by people with multimorbidity and their carers.

- To identify priorities for improving care for people with multimorbidity in order to reduce treatment burden.

- To explore the role of carers in supporting people with multimorbidity, and to understand the ways in which they currently help to alleviate treatment burden.

4.6.3 Setting

Participant identification and initial approach was undertaken at the Queen Elizabeth University Hospital (QEUH) ED. The QEUH ED is a busy urban emergency department in Glasgow, attended by approximately 7800 patients each month (Public Health Scotland, 2022). The QEUH is the largest hospital in Scotland and one of the largest in the UK. It also hosts the major trauma centre for the West of Scotland. The high volume of patients coupled with the wide variations in the acuity of presentations makes the QEUH ED an excellent setting in which to identify people with multiple chronic conditions who may experience treatment burden.

Further justification for this setting can be found in the fact that it is a highly research-active clinical area, with a dedicated multidisciplinary clinical research team comprising emergency medicine consultants, research fellows, and clinical research nurses. The author of this thesis worked as a clinical research nurse in the department, and this familiarity with the context, departmental processes (having also worked in the department for several years as a staff nurse), and patient group facilitated recruitment without disrupting care. Alternative methods of recruitment (covered later in this section) were also planned, as it was anticipated that the refusal rate in the ED could be high. However, attempting recruitment within this setting was seen as important in order to avoid restricting access to those who were active online.

A mix of physical and online options were offered for study procedures, including meeting participants in their own homes or using video conferencing. The option of coming to the Clinical Research Facility at the QEUH for interviews was also available. While this was not a naturalistic setting, it was important to ensure that an accessible and safe location was available to those who did not want to be interviewed at home or using video conferencing software.

4.6.4 Sample and recruitment

Participants were people with multimorbidity (including one of five index conditions) and their unpaid carers. The target sample was 6-10 patient and carer teams (12-20 people).

Questioning sample size in qualitative research will seldom result in an objective number of participants which is the ‘correct size’ for the methodological approach. Pragmatism and the concept of data saturation (with its origins in grounded theory) tend to govern researchers’ decisions with regards to sample size; therefore, justification of sample size should be made comprehensively by authors with relation to intrinsic factors of the study (Vasileiou et al., 2018). Relying largely on fieldwork and prolonged observations, arriving at a sample size in ethnographic research is similarly driven by the aims of the research (Fetterman, 2020). In focussed ethnography, where the culture under study may be disparate but connected by shared experience or identities (Wall, 2015), this remains the case. This study aimed to capture intercultural diversity in understanding the uniqueness of the population under study, while also seeking to detect *intra*cultural differences within the sample (Fetterman, 2020). It was anticipated that a sample of 12-20 people would be achievable while allowing sufficient depth of analysis.

4.6.4.1 Deciding on index conditions

The five index conditions (chronic heart failure, chronic kidney disease, chronic obstructive pulmonary disease (COPD), cancer, dementia) were chosen to achieve a balance between being inclusive while ensuring that the people recruited had significant chronic illness as part of their multimorbidity. As discussed earlier in the thesis, these are conditions which were considered to be palliative conditions, although not necessarily associated with end-of-life care needs. Chronic kidney disease for example, can have a long prognosis and range from relatively mild to life-threatening. A pragmatic decision on these five conditions was made because they affect different bodily systems, and because they were found to be the most common palliative conditions in the population under investigation (McParland et al., 2022a).

4.6.4.2 Patient eligibility criteria

In order to be eligible to participate, patient participants had to meet all of the eligibility criteria and none of the exclusion criteria.

Inclusion criteria

Patient participants must:

- Be aged 18 or older
- Live in the NHSGGC board area
- Have one or more of the following chronic conditions: chronic heart failure, chronic kidney disease, COPD, cancer, dementia (mild or moderate cognitive impairment).
- Have two or more chronic conditions (including one of the above)
- Be able to speak, read and understand English
- Have an unpaid carer who is willing and able to participate in the study
- Have capacity to provide informed consent. Failing this, consent can be provided by a nearest relative/guardian or welfare attorney in line with the process outlined in section 4.6.4.4 (Adults with incapacity). The person providing consent must also be a participating carer in the study.

Exclusion criteria

Patient participants must not:

- Be under 18 years old

- Live outside NHSGGC
- Have fewer than two chronic conditions
- Be unable to speak, read and understand English
- Lack an unpaid carer
- Lack capacity to provide informed consent or a participating carer who is eligible to provide informed consent on their behalf

4.6.4.3 Carer eligibility criteria

In order to be eligible to participate, carer participants had to meet all of the eligibility criteria and none of the exclusion criteria.

Inclusion criteria

Carer participants must:

- Be aged 18 or older
- Have a participating relative or friend who meets all of the above inclusion criteria
- Live in the NHSGGC board area
- Be able to speak, read and understand English
- Have capacity to provide informed consent for their own participation as a carer.
- Have capacity and legal authority to provide informed consent on behalf of the patient participant if the patient participant is an adult with incapacity. If their relative or friend lacks capacity to provide informed consent, the carer must also be the individual who is eligible to consent

on their relative’s behalf, i.e. nearest relative/guardian or welfare attorney.

Exclusion criteria

- Carer participants must not:
- Be under 18 years old
- Have a participating relative or friend who meets any of the above exclusion criteria
- Live outside NHSGGC
- Be unable to speak, read and understand English
- Lack capacity to provide informed consent for their own participation as a carer
- Lack capacity and legal authority to provide informed consent on behalf of the patient participant if the patient participant is an adult with incapacity.

4.6.4.4 Adults with incapacity

People with cognitive impairment are often excluded from research due to concerns about capacity and consent (Ries et al., 2017). However, people should have the opportunity to take part in research when the findings may affect them. There is no shortage of calls to avoid the routine exclusion of adults with incapacity from research, providing adequate safeguards and governance structures are in place to protect them (see for example the guidelines issued by the Scottish Dementia Working Group (2014) and Alzheimer’s Europe (Gove et al., 2018)).

The Adults with Incapacity (Scotland) Act (The Scottish Government, 2000) provides a framework through which people who lack capacity to provide informed consent can participate in research. In the event that someone is unable to consent due to incapacity, a legal representative can provide consent on their behalf. In the first instance this should be the person's welfare attorney or welfare guardian. If no such individual exists, consent can be provided by the persons nearest relative. In the context of patient representation, the Mental Health (Care and Treatment) (Scotland) Act (The Scottish Government, 2003) defines a person's nearest relative to be (in descending order): (1) Spouse; (2) Child; (3) Father or mother; (4) Brother or sister; (5) Grandparent; (6) Grandchild; (7) Uncle or aunt; (8) Nephew or niece.

People with incapacity were eligible for inclusion in this study provided that the legal representative was also their primary carer and was also willing to participate.

It was anticipated that fluctuating capacity was unlikely; however, consent forms contained optional clauses where someone could express whether they would wish to continue in the study if they lost capacity, and in this eventuality consent would be sought from their carer (providing they were the persons legal representative). If someone regained capacity during the study, a separate participant information leaflet and consent form had been designed which would be provided to them. They would then be in a position to decide whether to continue in the study or not.

Further details on the ethical approvals secured to conduct this research follow later in the chapter (page 121).

4.6.4.5 Recruitment from the ED

With the approval of the clinical director and lead nurse, information slides were sent to all clinical staff telling them about the study and providing contact details for the researcher. It was agreed that clinical staff would identify potentially eligible patients and ask them if they would be happy to speak to a researcher. If they provided assent, the clinician would contact the researcher and document this assent in the clinical notes. Recruitment was mostly conducted during weekdays 8am-4pm.

Patients were then approached by the thesis author, who explained that they were a PhD student, a registered nurse, and that this project was part of their doctoral research. Participants were provided with a summary of the study, informed of their right to ask questions, or to refuse/withdraw without having to provide a reason. They were also provided with a participant information leaflet and given time to read the document before having any questions addressed. If the patient was willing to consider taking part, they were screened for eligibility. Providing participants were eligible and interested, Contact over telephone or email was arranged for at least three days later. Recognising that many patients would be admitted to hospital this was a minimum timeframe, and some were not contacted till after this point.

If the person's carer was not in the ED, the patient was provided with a carer information sheet and asked to pass it on so that the carer could contact if they were interested.

4.6.4.6 Recruitment online

Approval was also granted for a secondary recruitment process. A recruitment flyer with details of the study, contact information and a link to the participant information sheet was shared electronically through the mailing list of the Health and Social Care Alliance (the Alliance), a national third-sector intermediary for a range of health and social care groups. The same flyer was also shared publicly on the microblogging site Twitter (now known as 'X' at time of writing) by the author and the supervisory team. In both cases, interested parties were invited to contact the researchers and express interest. The process of sharing information, answering questions and screening for eligibility was conducted either by email or telephone dependant on participant preference.

4.6.5 Informed consent

Once participants had a minimum of three days to read, question, and reflect on the participant information sheet, they were contacted to ask whether they would like to participate. If they did, a meeting was arranged at a time and place convenient to them. Suggested venues were at the participants home or at the QEUH clinical research facility.

Participants were again given the opportunity to ask questions about the study and answers were provided. If they were happy to proceed, they were guided through the completion of a consent form, which was read and countersigned by the researcher. Consent forms were completed in duplicate, with one copy provided to the participant and one retained in the investigator file.

For participants who wished to meet remotely, it was agreed that consent could be obtained remotely. In these cases, consent forms were sent out alongside pre-paid return envelopes, and a call was arranged to discuss and read through the forms with participants. They were then able to return the consent forms in the prepaid return envelope. Prior to the commencement of the first interview, the consent form was also read and verbal confirmation of consent was obtained.

4.6.6 Data collection

Various approaches to data collection were employed; semi-structured interviews, participant observation, and participant diaries of experiences which they feel are burdensome (treatment burden journals). The rationale for this approach was to allow for data triangulation (Denzin, 2009), i.e., triangulation across different data sources from the same participant – not to be confused with the methodological triangulation discussed earlier. The type of triangulation employed here is a basic component of ethnographic research, yet it is essential to ensuring the findings are valid, comprehensive and contextualised appropriately (Fetterman, 2020).

4.6.6.1 Semi-structured interviews

The first interview was conducted at the first visit once informed consent had been obtained and involved both participants and carers. It was audio recorded (either using a digital recorder or recording software, dependant on how the interview was conducted), and later professionally transcribed. The closing interview took place on the final visit, alongside collection of the treatment burden journal. Both interviews were semi-structured around a topic guide (Appendix 8), although this was itself only intended to guide the researcher toward key areas of treatment burden which should be discussed across the two interviews. The following domains were included in the topic guide: medicines, self-management, access to healthcare services, social and personal dimensions, and the impact of the COVID-19 pandemic. These domains were based on areas covered in existing validated quantitative measures of treatment burden (Duncan et al., 2018; Tran et al., 2014). It was not possible to pilot the topic guide prior to the interviews; however, the style of interviewing allowed adequate flexibility to focus on areas of interest rather than rigidly adhering to the questions and prompts in the topic guide.

4.6.6.2 Participant observation

Participants were also invited to nominate a treatment burden experience which they would like the researcher to observe. The specific nature of this optional session was decided by the participants.

During observation sessions, notes were taken and questions were asked, but these were not structured in the manner of an interview. After the session, a reflexive summary of the session was written up by the researcher and this (along with any field-notes) was added to the data for analysis.

4.6.6.3 Treatment burden journals

Participants were invited to document as much or as little as they wanted in a ‘treatment burden journal’. This was simply a blank notebook provided at the initial visit, alongside an information sheet which gave examples of the sort of thing they might want to document (time spent, costs incurred, emotional demands etc.). It was also emphasised that there was no specified format required and that they could document anything they wanted to share with the researchers, in any way they felt comfortable.

4.6.6.4 Accessibility

A large part of the work undertaken in partnership with the EMBARQUE PPI group was related to ensuring that the study was accessible to people who due to illness or disability are often excluded from participating in research. The previous sections have referred to mostly face-to-face interviews and paper handwritten journals, but alternatives were also made available.

All interviews were able to be conducted remotely or over the telephone if travel or face-to-face contact was not suitable. All study documentation was offered to be read to participants and available in large and giant versions in keeping with the specifications outlined by the Royal National Institute for the Blind (2022). Plain-text versions of all documents were also available, which were tested and compatible with electronic reading software. In place of handwritten journals, easy-to-operate digital electronic recording devices were provided to participants to record their thoughts, if this was preferable. Approval was also granted to receive electronic data in any format preferred via email, if for example someone made use of assistive technologies which had not been considered.

4.6.7 Data analysis

Data were analysed using reflexive thematic analysis (rTA) as outlined by Braun and Clarke (2022). The theory of this approach is discussed in the preceding chapter; the practical steps are as follows:

Phase1 (dataset familiarisation): Immersion in the data involves repeated readings of and listening to data. Initial analytic ideas are written down.

Phase 2 (coding): The systematic and inductive application of both semantic (surface-level) and latent (implicit) codes to the entire dataset.

Phase 3 (generating initial themes): Identification of patterns within the dataset and clustering codes which meaningfully address the aims and objectives of the research. This step results in candidate themes.

Phase 4 (developing and reviewing themes): Assessing the fit of initial candidate themes to the data. They may require significant revision if they are not coherently organised around a central concept. Relationships between and within candidate themes is also reviewed with a view to splitting candidate themes or collapsing them together where necessary.

Phase 5 (refining, defining, and naming themes): Writing a brief synopsis of each theme, creating concise and meaningful names for themes. It is imperative at this stage to ensure the study aims and objectives are addressed by the themes generated.

Phase 6 (writing up): Writing up is recognised by Braun and Clarke as a core analytical stage in reflexive thematic analysis. Final themes are presented narratively.

All audio data were transcribed by a professional transcription service. All handwritten data were word-processed or scanned electronically. All data (now electronic) were analysed using NVivo (QSR International Pty Ltd, 2020).

4.6.7.1 Integration of theory

As discussed in the preceding chapter, Burden of Treatment Theory (May et al., 2014) provided an analytical framework for this phase of the thesis. In practical terms, this involved inputting the concepts into NVivo as an a priori thematic framework, structured by the generative mechanisms discussed in Figure 3-6 (page 51). Systematic mapping of data to these concepts took place alongside inductive coding during phase 2 of rTA as described above.

Two further theories were also added during the analysis, namely the concepts of uncertainty tolerance (Hillen et al., 2017) and total uncertainty (Etkind et al., 2022). These were introduced around phase 3 to 4 of rTA, as themes were developed from initial themes to more coherent ones. Concepts from these theories such as social uncertainty, physical uncertainty (Etkind et al., 2022), cognitive response, or probabilistic uncertainty (Hillen et al., 2017) were entered into NVivo and the earlier codes and themes were then structured around these and the themes related to Burden of Treatment Theory. Through a process of refinement and inductive coding within these themes, the final analysis was arrived at (phase 5 of rTA). This was further refined during the process of writing up (phase 6).

4.7 Ethical approvals

All relevant ethical approvals were secured prior to the commencement of each phase of the research. The mixed-methods systematic review did not require any such approvals.

4.7.1 Local Privacy Advisory Committee (LPAC)

Delegated ethics approval was granted for linkage to NHS patient data by the LPAC at NHSGGC. Approval to conduct the cross-sectional study of ED attenders was granted on 3rd September 2021 – a letter confirming this approval is in Appendix 5.

4.7.2 NHS Research Ethics Committee (REC)

Approval to conduct the EMBARQUE study was sought from an NHS Research Ethics Committee (REC). As the study was to involve adults with incapacity, and as it was to be conducted in Scotland (where legislation differs from England and Wales), it had to be reviewed by Scotland REC A, the only REC authorised to review such studies. Scotland REC A returned a favourable opinion on 10th January 2023 – a letter confirming this is in Appendix 9.

4.7.2.1 Challenges in obtaining ethical approval

The EMBARQUE study was sponsored by NHSGGC, and prior to submitting to REC it required approval from the study sponsor. During this process of approval, some parts of the study were amended or removed as they were deemed too high-risk. Permission to conduct observation was seen as particularly problematic and had to be significantly pared back before being made an optional component of the study. It was felt by the researchers that this was an important part of the study however and essential to a focussed ethnographic approach, so every effort was made to retain this feature, albeit in its reduced and optional format.

The EMBARQUE PPI group had also felt strongly that making use of routinely-used technologies to collect data would be extremely useful, and in particular the original study made provision for people to provide information using the end-to-end encrypted messaging platform WhatsApp. This was set to be a one-way system of communication and was intended to elicit immediate reflections on burdensome experiences either alongside or in place of the treatment burden journal. Some precedent had also been found for the use of WhatsApp in healthcare research including in the UK (Manji et al., 2021). Ultimately, however, this feature was seen to be too high-risk by the study sponsor despite robust data security measures taken by the researchers in designing the study.

4.7.2.2 Local research and innovation (R&I) approval

To conduct research within an NHS health board, approval from the local research and innovation (R&I) office is also required. NHS board approval was received on the 17th January 2023, as confirmed by a letter in Appendix.

4.8 Intervention development

In the final stage of the thesis, an intervention is proposed for how nurse-led care may be provided to people with multimorbidity and palliative conditions. The intervention is informed by the findings of the thesis, and it will be discussed with reference to the updated MRC guidance on the development of complex interventions (Skivington et al., 2021). The updated MRC guidance acknowledges four perspectives on intervention design: efficacy, effectiveness, theory-based, and systems-based approaches. This thesis adopts a theory-based approach, which seeks to understand how change is brought about including by understanding the interplay of mechanisms and context. The guidance recommends considering the following six questions at each stage of development (Skivington et al., 2021), therefore these will be discussed at the end of the thesis:

- How does the intervention interact with its context?
- What is the underpinning programme theory?
- How can diverse stakeholder perspectives be included in the research?
- What are the key uncertainties?
- How can the intervention be refined?
- What are the comparative resource and outcome consequences of the intervention?

4.9 Chapter summary

This chapter has outlined the methods deployed across the three phases of the research. A mixed methods systematic review of nurse-led interventions was followed by a cross-sectional study of ED attenders which explored the association between multimorbidity and negative outcomes in ED attenders. The final phase comprised a focussed ethnography of people with multimorbidity and their carers, exploring how they experience treatment burden. The following three chapters outline the findings of these phases.

Chapter 5. Mixed-methods systematic review of nurse-led interventions for people with multimorbidity – findings

5.1 Introduction

This initial phase of the research was intended to address two questions. Firstly, what types of nurse-led interventions have been developed and evaluated, and secondly; what effects these interventions have on a range of outcomes. A mixed-methods systematic review of the literature following the convergent integrated approach outlined by JBI was conducted. The protocol was pre-registered (PROSPERO ID: CRD42020197956) in October 2020 and updated in March 2021 to reflect changes made to the eligibility criteria, and the decision to adopt the JBI methodology with its associated data extraction/quality appraisal tools. The results were published in the Journal of Advanced Nursing in September 2022 (McParland et al., 2022b).

The searches were updated in June 2023 during the preparation of this thesis. This chapter presents the synthesised findings of research published up to this date. Where the findings presented here differ from those in the published article (Appendix 3), these are addressed later in section 5.3.

5.2 Included studies

Twenty-eight studies (36 reports) were included in the review (Boult et al., 2008; Boult et al., 2011; Boyd et al., 2010; Boyd et al., 2008; Chow and Wong, 2014; Dorr et al., 2008; García-Fernández et al., 2014; Gustafsson et al., 2013; Hanson et al., 2018; Hjelm et al., 2015; Hummel et al., 2017; Jackson et al., 2016; Karlsson and Karlsson, 2019; Leff et al., 2009; Lupari, 2011; Mallow et al., 2018; Markle-Reid et al., 2016; Markle-Reid et al., 2018; Miklavcic et al., 2020; Moran et al., 2008; Randall et al., 2014; Randall et al., 2015; Sadarangani et al., 2019; Steinman et al., 2018; Sylvia et al., 2008; Takahashi et al., 2016; Taveira et al., 2019; Valdivieso et al., 2018; Doyle et al., 2022; Gabbard et al., 2021; Lowe et al., 2022; Markle-Reid et al., 2021; Mesa-Melgarejo et al., 2022; Moreno-Chico et al., 2021; Piñeiro-Fernández et al., 2022; Yang et al., 2022). A summary table of the included studies can be found in Appendix 11.

5.2.1 Screening

The searches yielded a total of 4,485 citations (3,420 in the original review and 1,065 in the update), and 164 full-text reports were assessed for eligibility following deduplication and title and abstract screening. Notably, no grey literature was retrieved during the updated search despite repeating the same methods employed in the original search. Table 5-1 presents a summary of the main reasons for the exclusion of full-text reports (across both searches):

Reason for exclusion	Number of reports excluded
Not multimorbidity focussed	50
Does not describe nurse-led care	20
Background paper	17
Neither multimorbidity nor nurse-led care focussed	9
Comorbidity (index condition) focussed	9
Ongoing study (no results)	7
No intervention described	7
Non-English language	4
Abstract only	3
Review paper	2
Total excluded	**128**

Table 5-1: Summary reasons for exclusion of full-text reports from the review

A sizeable number of excluded studies did not report on multimorbidity, or simply assumed the presence of multimorbidity due to the population being of an advanced age (n=50). Others were comorbidity focussed, relying on the presence of a particular index condition to which others are considered co-morbid (n=9). This further emphasises the need for better use of definitions when describing multimorbidity and differentiating it from comorbidity (Harrison et al., 2021). Figure 5-1 and Figure 5-2 outline the screening process for both the original and updated review.

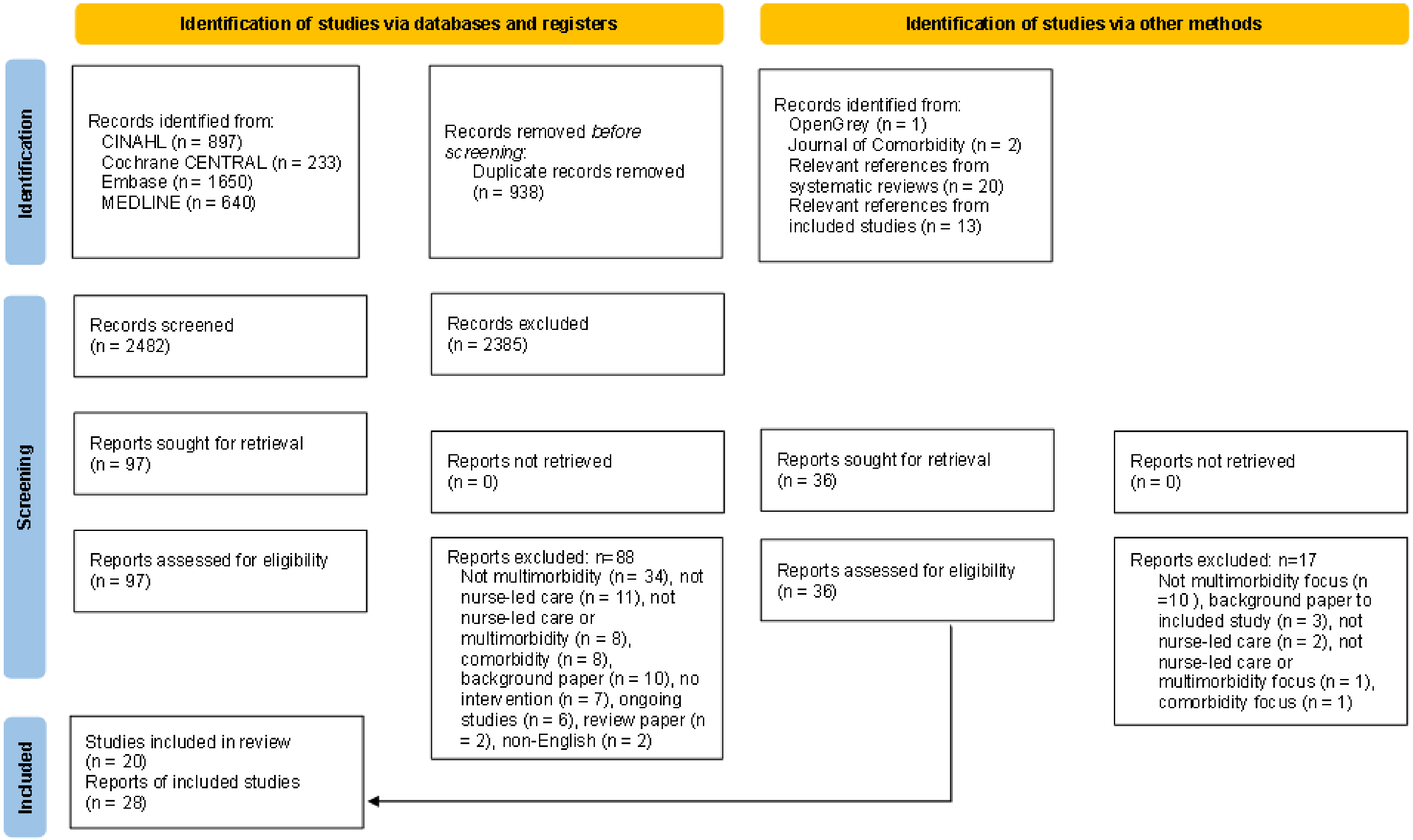


Figure 5-1: PRISMA flow diagram of included studies (original review)

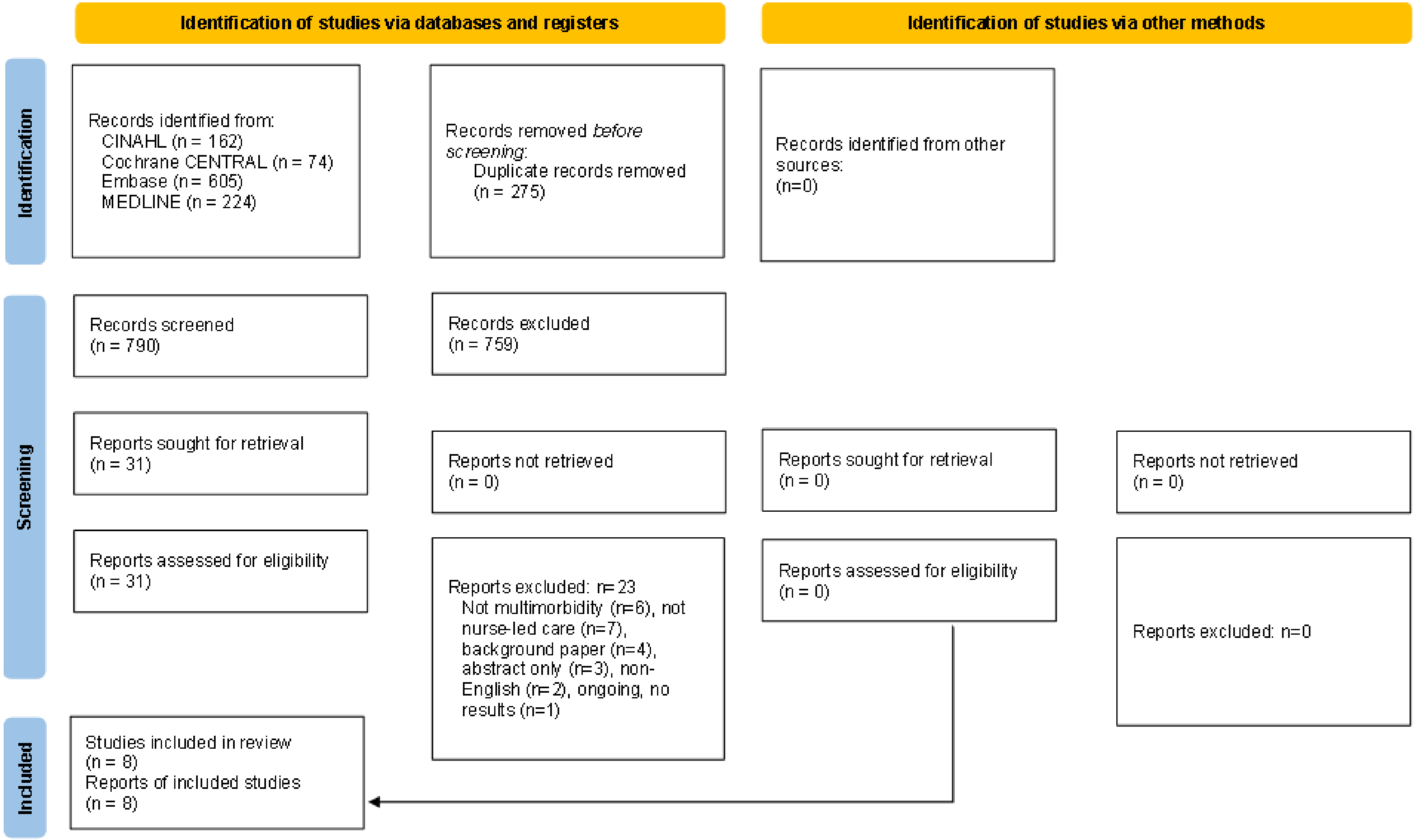


Figure 5-2: PRISMA flow diagram of included studies (2023 update)

5.2.2 Characteristics of included studies

The majority of studies employed quantitative methods (n=21), four used qualitative methods and three were mixed-methods studies. Of the quantitative studies, four were retrospective analytical cohort studies, six were pre/post-test quasi-experimental studies, five were nonrandomised controlled trials, six were randomised controlled trials. One qualitative study adopted a focussed ethnographic approach, the remaining three were descriptive/exploratory. All mixed-methods studies supplemented findings from quasi-experimental studies with qualitative descriptive/exploratory interviews or focus groups.

The majority of studies were from North America and Europe (n=23), none were from low or middle-income countries. Nine studies were from the USA, four from Spain, three from the UK (England, Northern Ireland and Wales), three from Canada, two from Sweden, and one each from Australia, Colombia, China, Hong Kong, Israel and Portugal. One study was undertaken at sites in both Ireland and Belgium.

Two included studies (one from the USA and one from Canada) were pilot studies of larger randomised controlled trials which were also included in the review. As these pilot studies employed different methods and reported findings separately to the larger trials, they were treated as separate studies for the purpose of the review.

Sample sizes varied greatly ranging from 10 nurses for a qualitative descriptive/exploratory study, to 35,174 patients for a large cohort study. The mean sample size was 1640.7 (median 155.5). Considering only patient participants results in a similarly varied range (13-35,174) mean (1761.4) and median (1551.5) number of participants.

5.2.2.1 Identification of multimorbidity and inclusion criteria

The approach to identifying a sample of people with multimorbidity, or of defining multimorbidity, also varied greatly between studies. Many studies required a count of at least two (or three) chronic conditions, the generally accepted definition of multimorbidity. Two studies (a pilot study and subsequent RCT) also required a diagnosis of diabetes in addition to multimorbidity (Markle-

Reid et al., 2016; Markle-Reid et al., 2018; Miklavcic et al., 2020), while another required participants to be experiencing depressive symptoms (Markle-Reid et al., 2021). However, on reviewing these interventions they were agreed between reviewers to be multimorbidity-focussed and eligible for inclusion. A common approach to sampling involved the use of predictive models which identified persons at high risk of healthcare utilisation. In selecting studies which made use of such models for inclusion, care was taken to ensure that the criteria for participants would require a combination of chronic disease, somatic and biopsychosocial risk factors, and where possible that the sample was sufficiently multimorbid based on disease-count. Predictive models which did not focus on morbidity and instead prioritised advanced age or perceived frailty were not included in the review. One study was multimorbidity-focussed but only required a minimum of one chronic condition (Moreno-Chico et al., 2021). However, the majority of the sample had at least two chronic conditions and the intervention was transdiagnostic, therefore it was deemed eligible. Other approaches included identifying multimorbid populations through clinician judgement (in which multimorbidity was a criterion) (Dorr et al., 2008) and a combination of chronic disease and psychosocial risk factors including being uninsured, having a low income and poor access to health care (Mallow et al., 2018).

5.2.2.2 Participant characteristics

The average age of participants was reported in 24 studies and ranged from 37.98 to 83.56 (mean = 74.72, median = 76.05), reflecting the fact that many (n=15) studies had an age restriction which limited participants or recipients of care to older adults (generally ≥65 years old). Fourteen studies reported an average number of chronic conditions, ranging from 2.6 to 12 (mean = 6.04, median = 4.3). All studies recruited participants from both sexes and were broadly even across the included studies.

5.2.3 Quality of included studies

All studies were appraised by two independent reviewers and discrepancies were resolved through discussion. For each question, reviewers were able to answer ‘yes’, ‘no’, ‘unclear’ or ‘not applicable’. A summary quality score was also calculated, which is the proportion of questions answered ‘yes’, expressed as a percentage. Table 5-2 provides an overview of the summary quality scores.

Study type	Number of studies†	Summary quality score Median	Range	Interquartile range
Randomised controlled trials	6	77.0	77-85	77.0-77.0
Quasi-experimental studies	14	67.0	33-89	56.0-86.3
Retrospective cohort studies	4	73.0	55-100	55.0-93.3
Qualitative studies	7	80.0	50-90	60.0-85.0
All studies	28	77.0	33-100	56.0-87.0

†Number of studies greater than 28. Mixed-methods studies scored on both qualitative and quantitative components

Table 5-2: Overview of summary quality scores of included studies. Updated from McParland et al (2022)

The full details of how individual studies were scored is in Appendix 12. There were no major issues with the quality of studies, but there were some patterns in the areas where certain designs were scored down. Common issues in randomised controlled trials included limited blinding of participants and treating clinicians, although this is admittedly challenging when delivering a complex intervention. Quasi-experimental studies were often a pre/post-test design and lacked a control group, and there were seldom multiple measurements of outcomes both before and after the intervention. Some cohort studies failed to handle confounders and follow-up adequately. Most qualitative studies were descriptive or exploratory, therefore lacked philosophical contextualisation, and there was a paucity of reflection on the impact of the researcher on the research.

5.3 Differences between published review and updated review

The original published systematic review (McParland et al., 2022b) searches were conducted in October 2020, therefore these were updated in June 2023 to capture any studies published in the intervening period. This resulted in the addition of eight studies (Doyle et al., 2022; Gabbard et al., 2021; Lowe et al., 2022; Markle-Reid et al., 2021; Mesa-Melgarejo et al., 2022; Moreno-Chico et al., 2021; Piñeiro-Fernández et al., 2022; Yang et al., 2022). The addition of these studies did not substantially change the overall interpretation of results. The ways in which they added to the results are as follows:

- The addition of an intervention which focussed solely on anticipatory care planning (Gabbard et al., 2021) meant that a further intervention category had to be created (anticipatory care planning interventions), alongside a further outcome (anticipatory care planning).

- Two studies measured the effects of interventions in reducing treatment burden (Doyle et al., 2022; Yang et al., 2022), an important concept which hadn't been measured in the original review. Therefore, the COSmm outcome 'treatment burden' was added to the updated analysis.

- A second information and communications technology (ICT) intervention was added in the updated review (Doyle et al., 2022); this provided qualitative evidence of effects on outcomes which were not measured by the ICT intervention included in the original review (self-management, self-efficacy, quality of healthcare, case-finding and referral, and treatment burden).

- The addition of triangulated mixed-methods findings which evidenced improved caregiver support resulting from a case management intervention (Mesa-Melgarejo et al., 2022) resulted in the interpretation of these effects being changed from 'mixed' to 'mostly improved'.

5.4 Intervention components

The first cycle of categorising interventions involved coding 'components' of interventions; these were defined as any discernible part of the intervention which differed from usual care. Iterative adaptions were made to the EPOC taxonomy (EPOC, 2015) to better reflect the intervention components which were being identified. The following changes were made:

- ‘Discharge planning’ was changed to ‘discharge planning/transitional care’, to reflect the prevalence of interventions which aimed to improve continuity of care at the point of discharge from hospital.

- ‘Continuity of care’ was changed to ‘continuity of care (excluding transitional care)’ to differentiate between interventions which sought to improve continuity in general with those specifically targeted at hospital discharges.

- ‘Self-management’ was changed to ‘supported self-management’, to better reflect the role of the nurse and interdisciplinary team in supporting patients, rather than simply transferring responsibility to the patient.

- ‘Site of service delivery’ was change to ‘nurse home visits’ to improve the specificity of this subcategory.

- ‘Role expansion or task shifting’ was changed to ‘nurse in advanced practice’. This subcategory was intended to capture any intervention which was led by a nurse with an advanced role. ‘Advanced’ in this instance includes any role other than ‘registered nurse’ or those related to specialty such as ‘community nurse’, ‘diabetes nurse’.

Inductive coding allowed for the identification of other components which did not fit within the EPOC Taxonomy. Additional subcategories were created and grouped under ‘other components’:

- ‘Nurse training’ – any described programme of education, including recognised academic qualifications (i.e., Masters degree) and role-specific training programmes.

- ‘Carer education and support’ – any education and support provided directly to caregivers of people participating in the intervention.

- ‘Motivational interviewing’ – requires that the nurse is trained in and employs motivational interviewing techniques to support changes in behaviour.

- ‘Connecting with community resources’ – any instances of signposting or connecting participants with community and social care resources they may be eligible for.

- ‘Proactive case finding and referrals’– can relate to proactively identifying patients who would benefit from the intervention under investigation, or proactively identifying patients within current caseload who would benefit from referral to another service.

- ‘Medication management’ – specific component of intervention intended to review medications, generally focussing on polypharmacy.

- ‘Anticipatory care planning and end of life care’ – identifying and documenting treatment preferences at the end of life or providing care at the end of life.

A thematic framework was created in Nvivo 12 based on this adapted taxonomy. Data extraction forms were indexed systematically using the thematic framework outlined in Table **5-3**.

1.1 Changes to where care is provided
1.1.1 Nurse home visits
1.2 Changes to who provides care
1.2.1 Nurse in advanced practice
1.2.2 Support to self-manage
1.3 Coordination of care and management of care process
1.3.1 Case management
1.3.2 Comprehensive geriatric assessment
1.3.3 Continuity of care (excluding transitional care)
1.3.4 Discharge planning/transitional care
1.3.5 Disease management
1.3.6 Teams (interdisciplinary)
1.4 Information and communications technology (ICT)
1.4.1 Health information systems
1.4.2 Use of ICT
1.4.3 Telemedicine
1.5 Governance- authority and accountability
1.5.1 Stakeholder involvement in policy
1.5.2 Prescribing
1.6 Other components
1.6.1 Nurse training
1.6.2 Carer education and support
1.6.3 Motivational interviewing
1.6.4 Connecting with community resources
1.6.5 Proactive case finding and referrals
1.6.6 Medication management
1.6.7 Anticipatory care planning and end of life care

Table 5-3**: Thematic framework based on adapted EPOC taxonomy (EPOC, 2015)**

The most common intervention components were including a nurse in advanced practice to lead the intervention (n=22), case management (n=16) and supporting patients to self-manage conditions (n=13). Figure **5-3** provides an overview of the intervention components identified.

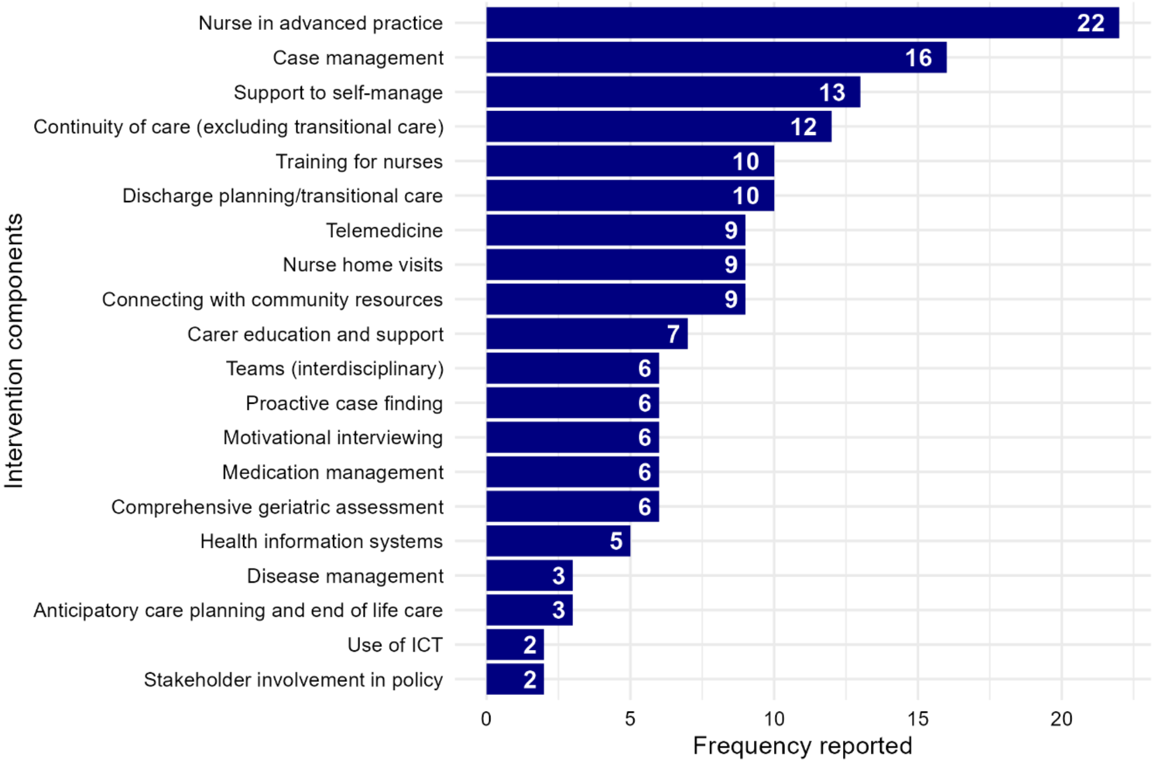


Figure 5-3: **Summary plot of intervention components. Updated from McParland et al (2022)**

Interventions were generally complex: the mean number of components per intervention was 4.5 (range 2-12). The prevalence of nurses in different forms of advanced practice is perhaps unsurprising given that interventions are nurse-led, yet there is a great deal of variety of the types of nursing roles described. Three interventions (from the US, UK and China) specifically required advanced practice nurses (Chow and Wong, 2014; Hanson et al., 2018; Randall et al., 2014), eight studies (from the US, UK, Colombia, Portugal and Spain) only specified a nurse case-manager or equivalent (Dorr et al., 2008; García-Fernández et al., 2014; Jackson et al., 2016; Moran et al., 2008; Taveira et al., 2019; Valdivieso et al., 2018; Mesa-Melgarejo et al., 2022; Piñeiro-Fernández et al., 2022), and three studies from the US and Australia specified a nurse-practitioner (Hummel et al., 2017; Mallow et al., 2018; Lowe et al., 2022). Two studies from the US were led by a Nurse Navigator (Gabbard et al., 2021; Sadarangani et al., 2019).The remaining titles were unique to individual studies, and were as follows: Guided Care Nurse (US) (Boult et al., 2011; Boyd et al., 2008), Continuing Care Nurse (UK/Northern Ireland) (Lupari, 2011), Triage Nurse (Belgium and Ireland – not to be confused with the traditional role of the emergency department triage nurse) (Doyle et al., 2022), and CC-MAP Nurse (Israel) (Steinman et al., 2018). International variation in nursing titles poses a challenge to comparing these roles without greater information about the education, experience and role of the nurses described; however, details of the interventions were sufficient to establish these roles required a greater degree of autonomy than would be expected of more junior nursing roles.

5.5 Types of nurse-led interventions and their effects on outcomes

In order to establish a more useful typology, each intervention was additionally coded by the component which most adequately described the overall intervention. For example, if an intervention involved the introduction of a nurse case-manager to coordinate care, and that case-manager was able to provide home visits, transitional care, and medication management, it would be classified as a case management intervention, and the components as (i) nurse home visits, (ii) transitional care, and (iii) medication management. To describe such an intervention as a transitional care intervention, for example, wouldn't adequately capture the overall nature of the intervention. Figure 5-4 provides an overview of intervention types.

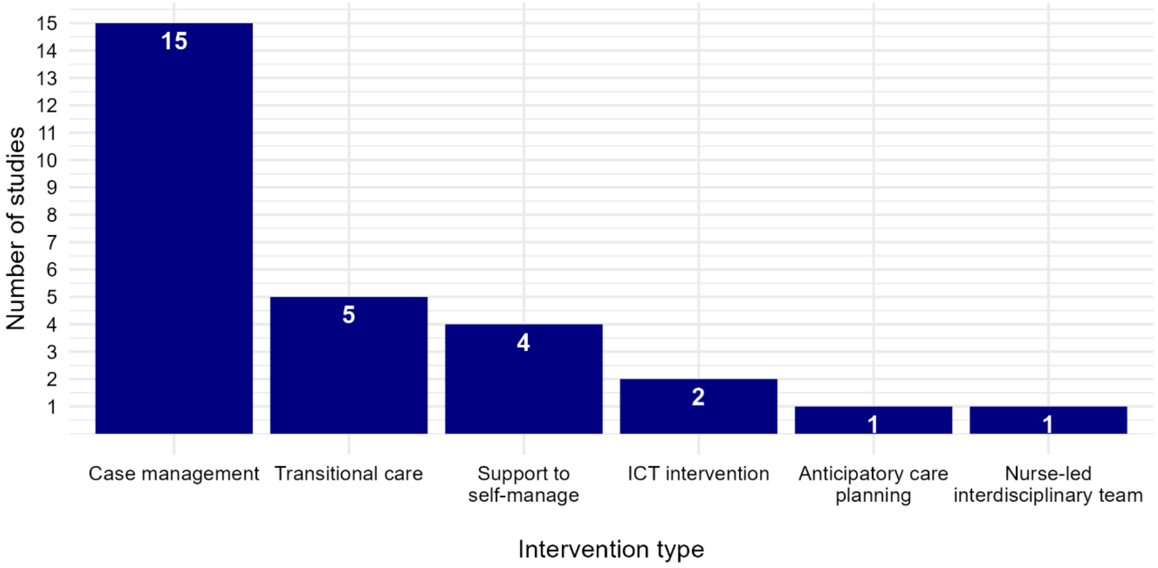
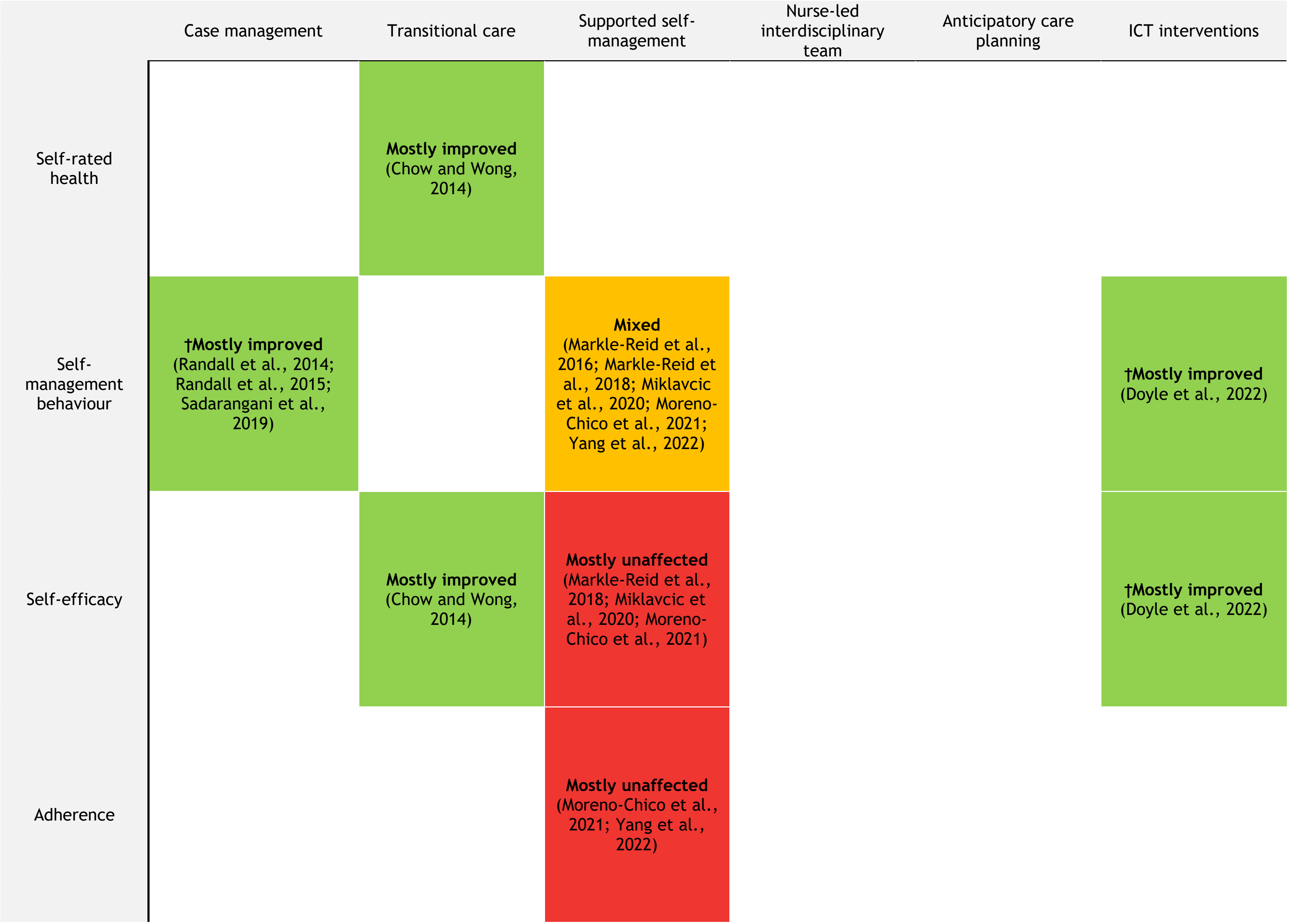


Figure 5-4: Summary of intervention types for n=28 included studies. Updated from McParland et al (2022).

The majority of studies (n=20) were either case management or transitional care interventions. Both types of intervention are concerned with coordinating care, typically of complex patients, and often with the intention of reducing healthcare utilisation and costs. The distinction between these is that case management interventions are often long-term, while transitional care is shorter and targeted at high-risk care transitions such as hospital discharge.

The following sections summarise each intervention type and the effects they have on a range of outcomes. The effects are also summarised in Table 5-4.

	Case management	Transitional care	Supported self-management	Nurse-led interdisciplinary team	Anticipatory care planning	ICT interventions
Health related quality of life	**Mostly improved** (Lupari, 2011; Sadarangani et al., 2019; Valdivieso et al., 2018; Mesa-Melgarejo et al., 2022)	**Mostly improved** (Chow and Wong, 2014)	**Mixed** (Markle-Reid et al., 2016; Markle-Reid et al., 2018; Miklavcic et al., 2020; Moreno-Chico et al., 2021; Yang et al., 2022)			
Mental health	**Mixed** (Sadarangani et al., 2019; Valdivieso et al., 2018)	**Mostly unaffected** (Markle-Reid et al., 2021)	**Mostly unaffected** (Markle-Reid et al., 2016; Markle-Reid et al., 2018; Miklavcic et al., 2020; Moreno-Chico et al., 2021)			
Mortality	**Mixed** (Dorr et al., 2008; García-Fernández et al., 2014; Valdivieso et al., 2018)	**Mixed** (Takahashi et al., 2016)				
Treatment burden			**Mostly unaffected** (Yang et al., 2022)			**†Mostly unaffected** (Doyle et al., 2022)



	Case management	Transitional care	Supported self-management	Nurse-led interdisciplinary team	Anticipatory care planning	ICT interventions
Self-rated health		**Mostly improved** (Chow and Wong, 2014)				
Self-management behaviour	**†Mostly improved** (Randall et al., 2014; Randall et al., 2015; Sadarangani et al., 2019)		**Mixed** (Markle-Reid et al., 2016; Markle-Reid et al., 2018; Miklavcic et al., 2020; Moreno-Chico et al., 2021; Yang et al., 2022)			**†Mostly improved** (Doyle et al., 2022)
Self-efficacy		**Mostly improved** (Chow and Wong, 2014)	**Mostly unaffected** (Markle-Reid et al., 2018; Miklavcic et al., 2020; Moreno-Chico et al., 2021)			**†Mostly improved** (Doyle et al., 2022)
Adherence			**Mostly unaffected** (Moreno-Chico et al., 2021; Yang et al., 2022)			

	Case management	Transitional care	Supported self-management	Nurse-led interdisciplinary team	Anticipatory care planning	ICT interventions
Caregiver burden/support	***Mostly improved*** *(García-Fernández et al., 2014; Lupari, 2011; Sadarangani et al., 2019; Mesa-Melgarejo et al., 2022)*					
Pain	***Mostly improved*** *(Sadarangani et al., 2019)*					
Activities of daily living	**Mostly improved** (García-Fernández et al., 2014; Valdivieso et al., 2018; Mesa-Melgarejo et al., 2022)					
Physical function	**Mixed** (Lupari, 2011)	**Mostly unaffected** (Markle-Reid et al., 2021)				

	Case management	Transitional care	Supported self-management	Nurse-led interdisciplinary team	Anticipatory care planning	ICT interventions
Physiological measures						***Mixed*** *(Mallow et al., 2018)*
Disease management	***†Mostly improved*** *(Sadarangani et al., 2019)*					
Nutrition	***Mostly improved*** *(Sadarangani et al., 2019)*					
Falls risk	***Mostly unaffected*** *(Sadarangani et al., 2019)*					

	Case management	Transitional care	Supported self-management	Nurse-led interdisciplinary team	Anticipatory care planning	ICT interventions
Communication	**†Mostly improved** (Randall et al., 2014; Randall et al., 2015)	**Mixed** (Karlsson and Karlsson, 2019; Markle-Reid et al., 2021)				
Prioritisation	**Mostly improved** (Steinman et al., 2018; Sadarangani et al., 2019)					
Trust and advocacy	***†Mostly improved*** *(Gustafsson et al., 2013; Hjelm et al., 2015; Sadarangani et al., 2019)*					
Healthcare use	**Mixed** (Boult et al., 2011; Dorr et al., 2008; García-Fernández et al., 2014; Lupari, 2011; Moran et al., 2008; Sadarangani et al., 2019; Lowe et al., 2022; Mesa-Melgarejo et al., 2022; Piñeiro-Fernández et al., 2022)	**Mostly improved** (Jackson et al., 2016; Takahashi et al., 2016; Markle-Reid et al., 2021; Chow and Wong, 2014)	**Mostly unaffected** (Yang et al., 2022)		**Mostly unaffected** (Gabbard et al., 2021)	

	Case management	Transitional care	Supported self-management	Nurse-led interdisciplinary team	Anticipatory care planning	ICT interventions
Costs	**Mixed** (Lupari, 2011; Sylvia et al., 2008; Leff et al., 2009)	**Mixed** (Hanson et al., 2018; Jackson et al., 2016)	**Mixed** (Markle-Reid et al., 2016; Markle-Reid et al., 2018; Miklavcic et al., 2020)			
Quality of healthcare (patient-rated)	**Mostly improved** (Boult et al., 2008; Boyd et al., 2010; Boyd et al., 2008; García-Fernández et al., 2014; Hjelm et al., 2015; Randall et al., 2014; Randall et al., 2015)	**†Mixed** (Karlsson and Karlsson, 2019)	**Mostly unaffected** (Moreno-Chico et al., 2021)			**†Mostly improved** (Doyle et al., 2022)
Quality of healthcare (nurse/physician rated)	***Mixed*** *(Boyd et al., 2010; Randall et al., 2014)*					
Case-finding and referrals	***Mixed*** *(Sadarangani et al., 2019)*			***Mixed*** *(Hummel et al., 2017)*		***†Mostly improved*** *(Doyle et al., 2022)*

	Case management	Transitional care	Supported self-management	Nurse-led interdisciplinary team	Anticipatory care planning	ICT interventions
Anticipatory care planning					***Mostly improved*** *(Gabbard et al., 2021)*	

†Qualitative evidence only
Italicised outcomes not COSmm outcomes and were coded inductively

Table 5-4: Summary of effects of nurse-led interventions on outcomes. Updated from McParland et al (2022).

5.5.1 Case management interventions

Case management is a broad term with no single accepted definition; it is typified by individualised assessment of complex and chronically-unwell patients, care-planning, care coordination, and aims to ensure care is comprehensive and cost-effective (Shilpa Ross et al., 2011). It can be both long-term or short and targeted; however, in the context of this review most interventions tended to be at least several months long.

Case management interventions typically involved the development of individualised care plans, (Boult et al., 2011; Boyd et al., 2008; Sadarangani et al., 2019; Steinman et al., 2018; Lowe et al., 2022; Mesa-Melgarejo et al., 2022; Piñeiro-Fernández et al., 2022; Chow and Wong, 2014), and often emphasised continuity of care (Boult et al., 2011; Boyd et al., 2008; Lupari, 2011; Steinman et al., 2018; Taveira et al., 2019; Lowe et al., 2022; Mesa-Melgarejo et al., 2022; Piñeiro-Fernández et al., 2022). Advanced clinical skills such as prescribing and clinical assessment were part of the role of some case managers (Lupari, 2011; Randall et al., 2014) as they were the primary healthcare provider for the patient. Others supplemented the patient's existing primary care (Boult et al., 2011; Boyd et al., 2008; Steinman et al., 2018). In some cases, nurses were required to undertake bespoke training before adopting the case manager role (Boult et al., 2011; Boyd et al., 2008; Lupari, 2011; Moran et al., 2008; Steinman et al., 2018). While many interventions were situated in primary care (Boult et al., 2011; Boyd et al., 2008; Dorr et al., 2008; Steinman et al., 2018; Taveira et al., 2019), there were also examples in secondary care, taking place around the point of discharge and with strong elements of transitional care (García-Fernández et al., 2014; Valdivieso et al., 2018; Lowe et al., 2022; Piñeiro-Fernández et al., 2022). A large number of interventions also took place in the community, either in the patient's home or at community health centres (Hjelm et al., 2015; Lupari, 2011; Moran et al., 2008; Randall et al., 2015; Sadarangani et al., 2019; Mesa-Melgarejo et al., 2022).

5.5.1.1 Effect of case management interventions

The effects of case management interventions were mostly positive for health-related quality of life, self-management behaviour, caregiver burden and support, pain, activities of daily living, disease management, nutrition, communication, prioritisation, fostering trust and advocacy, and patient-perceived quality of healthcare.

The effect of case management interventions on reducing health care use and costs was less clear. Some studies did report reductions in bed-days and emergency care use for community-based interventions (Lupari, 2011; Sadarangani et al., 2019), and one small quasi-experimental pilot did detect as significant reduction in emergency, inpatient and outpatient care post-intervention (Lowe et al., 2022). Another intervention with strong elements of transitional care also reported a reduction in ED use and hospital admissions (Piñeiro-Fernández et al., 2022). However, two large studies of primary care case management interventions did not report significant reductions across a wide range of interactions with services in both primary and secondary care (Boult et al., 2011; Dorr et al., 2008). Two hospital-based interventions also did not detect reductions in healthcare use (García-Fernández et al., 2014; Valdivieso et al., 2018), and one study which took place in the community reported reductions in primary care and specialty consultations, but no reductions in emergency care use, admissions, hospital bed-days or medications dispensed (Mesa-Melgarejo et al., 2022). The effect of case management on healthcare costs were similarly mixed: one study in Northern Ireland did demonstrate a significant reduction in costs (Lupari, 2011), while two studies from the US failed to generate significant reductions (Sylvia et al., 2008; Leff et al., 2009).

The effect of case management on mortality was also mixed; one large study of a community-based intervention did detect a significant reduction in mortality at one year post-intervention, but this was not sustained at two years (Dorr et al., 2008). Two hospital based interventions failed to detect any reductions in mortality at 90 days (García-Fernández et al., 2014) and one year (Valdivieso et al., 2018) post-intervention.

Other areas where results were mixed included mental health (Sadarangani et al., 2019; Valdivieso et al., 2018), physical function (Lupari, 2011), case finding and referrals (Sadarangani et al., 2019), and quality of care from the perspective of nurses and physicians (Boyd et al., 2010; Randall et al., 2014). One study failed to detect any reduction in falls risk as a result of a community-based intervention (Sadarangani et al., 2019).

5.5.2 Transitional care interventions

Transitional care interventions are targeted interventions which aim to coordinate care and changes to the care process (EPOC, 2015) such as transfers between different care facilities or from hospital to home. All transitional care interventions included in this review focussed on hospital discharge, and most were intended to reduce the risk of rehospitalisation (Hanson et al., 2018; Jackson et al., 2016; Karlsson and Karlsson, 2019; Chow and Wong, 2014). One intervention aimed to reduce depressive symptoms (Markle-Reid et al., 2021). Home visits were a feature of all interventions, but others also used telephone calls (Markle-Reid et al., 2021; Chow and Wong, 2014). One study trialled the addition of nurse home-visits to an existing interdisciplinary transitional care intervention (Jackson et al., 2016).

5.5.2.1 Effect of transitional care interventions

Given their focus on reducing rehospitalisation, most interventions were assessed on their ability to reduce health care use and most studies were able to demonstrate reductions at various points post-intervention (Chow and Wong, 2014; Jackson et al., 2016; Takahashi et al., 2016; Markle-Reid et al., 2021). One intervention which combined home visits by a nurse in advanced practice with visits from nursing students and telephone calls also reported improvements in health-related quality of life, self-rated health, and self-efficacy (Chow and Wong, 2014). The effects of transitional care interventions on mortality, communication, costs, and patient-perceived quality of care were either mixed or reliant only on small qualitative studies. One study did detect a reduction in mortality at 30 days post-intervention, but this was not sustained at 90 or 190 days (Takahashi et al., 2016). Another study did identify that cost reductions could be made, but only if the intervention was targeted at the highest-risk strata of those who were identified using a predictive model (Hanson et al., 2018). Another study failed to detect a reduction in depressive symptoms or an improvement in physical function following intervention (Markle-Reid et al., 2021).

5.5.3 Supported self-management interventions

Supported self-management was a common component of many interventions, but only four studies reported interventions which could most accurately be described as supported self-management interventions. Successful self-management of chronic illness requires the patient to develop a range of skills, including the ability to identify and solve problems related to illness, to make both day-to-day and significant decisions, to identify and utilise helpful resources, to form beneficial partnerships with healthcare providers, and to take decisive action based on decisions made (Lorig and Holman, 2003). Two studies from the same research programme were included; these comprised home visits, group education sessions, case conferences and nurse-led care coordination (Markle-Reid et al., 2016; Markle-Reid et al., 2018; Miklavcic et al., 2020). Another emphasised health coaching, with the nurse being trained in motivational interviewing and aiming to improve patient activation (Moreno-Chico et al., 2021). Another employed similar methods but focussed solely on improving self-management in relation to medications (Yang et al., 2022).

5.5.3.1 Effect of supported self-management interventions

Mixed effects were reported in relation to health-related quality of life, costs, and most notably, the ability for patients to self-manage. One study found a small significant improvement in diabetes self-management (Markle-Reid et al., 2018), while the other arm of the same study and the pilot which preceded it did not detect a significant improvement (Markle-Reid et al., 2016; Miklavcic et al., 2020). Another study found an improvement in patient activation at six weeks post-intervention which was not sustained at later time points (Moreno-Chico et al., 2021). Medication self-management similarly improved post-intervention in one study but was non-significant at three months (Yang et al., 2022).

Several studies (using a range of validated measures) failed to detect any significant improvement in mental health resulting from supported self-management (Markle-Reid et al., 2016; Markle-Reid et al., 2018; Miklavcic et al., 2020; Moreno-Chico et al., 2021). No improvements were noted in relation to treatment burden, self-efficacy, adherence, healthcare use, and patient-perceived quality of healthcare.

5.5.4 Information and communication technology (ICT) interventions

Two studies described interventions which were nurse-led but centred around the use of ICT to improve care. In both studies, participants were provided with tablet computers and digital monitoring devices (such as Bluetooth-enabled scales, sphygmomanometers, smart watches and glucometers (where necessary)) which enabled remote monitoring of physiological parameters by the nurses administering the intervention. Both studies made use of bespoke applications for patients to interact with, and the participants were trained in the use of these. In one study, the nurse practitioner became the primary caregiver for the patient and would also conduct remote consultations and make referrals to services (Mallow et al., 2018). In the other study, the intervention was administered by a ‘triage nurse’ who monitored physiological parameters and advised the patient to self-refer to services such as primary care or specialists- the only exception being when an emergency ambulance was required (Doyle et al., 2022).

5.5.4.1 Effect of ICT interventions

There was qualitative evidence to suggest that ICT interventions improved self-management behaviour, self-efficacy, patient-perceived quality of care, and case finding/referrals (Doyle et al., 2022). The quantitative evidence from a small quasi-experimental study was hampered by a low response-rate, therefore only reported mixed effects on physiological measures; improvements in blood pressure and blood glucose, but no effect on weight-management (Mallow et al., 2018). There were also qualitative findings which indicated that such interventions could worsen treatment burden by causing patients to acknowledge and respond to alarms informing them that they have exceeded pre-determined physiological parameters, despite being within their individual normal range (Doyle et al., 2022).

5.5.5 Nurse-led interdisciplinary team interventions

Interdisciplinary team working was an explicit feature of six interventions, and due to the complex nature of caring for people with multimorbidity it is likely to feature in the many interventions where care coordination and case management were also components. However, only one intervention specifically focussed on evaluating the effect of introducing a nurse practitioner as the team leader of an interdisciplinary team compared with a smaller, physician-led team (Hummel et al., 2017). The nurse-practitioner led intensive management patient-aligned care team (imPACT) comprised a nurse practitioner (team leader), social worker, recreation therapist, administration coordinator and a part-time physician champion. This was compared with a less intensive PACT team comprising a physician (team leader), registered nurse, medical assistant and administrative assistant. The key features of the imPACT intervention involved 24/7 contact to either the nurse practitioner or physician, comprehensive interdisciplinary assessment and frequent follow up with the team, health education, coaching, hospital ‘in-reach’, co-attendance at hospital appointments, and connecting patients with community resources.

5.5.5.1 Effect of nurse-led interdisciplinary team interventions

The imPACT intervention resulted in increased referrals to hospice services. However, the intervention cohort had a larger proportion of people with cancer and dementia, and when these conditions were removed in sensitivity analyses, the effect was no longer significant.

5.5.6 Anticipatory care planning interventions

Only one intervention was specifically focussed on engaging patients in anticipatory care planning (Gabbard et al., 2021). The intervention comprised a nurse navigator-led interdisciplinary team in which the nurse was trained in having conversations around anticipatory care planning. The nurse would conduct a telephone conversation in which they would introduce the subject of anticipatory care planning to prime the patient, and then rate the level of readiness displayed by the patient. This information would be recorded on the electronic health record, and if the patient was willing to proceed, an appointment would be made with a primary care physician who would (with access to the information gathered by the nurse navigator) assist the patient in creating an anticipatory care plan (ACP).

5.5.6.1 Effect of anticipatory care planning interventions

In a randomised controlled trial, the intervention demonstrated a significant increase in documented ACPs, identification of surrogate decision makers, creation of advanced directives, appointment of a legal power of attorney, creation of medical scope of treatment forms, and billing for ACP discussions (Gabbard et al., 2021).

5.6 Chapter summary

This chapter has presented the findings of a mixed-methods systematic review of nurse-led interventions for people with multimorbidity. It has demonstrated that such interventions are complex, comprising multiple components. The types of interventions are most commonly case management or transitional care interventions, but they mainly aim to coordinate and improve the continuity of care. These interventions often improve patient-centred outcomes such as health-related quality of life, activities of daily living, or patient-perceived quality of care, but their effects on health service outcomes (such as utilisation and costs) are less conclusive. Furthermore, when identifying people with multimorbidity who may benefit from intervention, it is common practice to deploy predictive models in order to stratify risk of health service utilisation and target those who are most likely to benefit.

In the following chapter, the second phase of this research will explore the risk of healthcare utilisation and inpatient mortality in emergency department attenders, in order to identify whether multimorbidity (identified using validated algorithms) is significantly associated with these outcomes.

Chapter 6. Cross-sectional study findings

6.1 Introduction

In the first phase of this project, it was established that nurse-led interventions for people with multimorbidity mostly focussed on improving care through case management or transitional care. Despite these interventions being positively appraised by patients, their success is primarily measured by their ability to reduce healthcare use. In this domain, the evidence is mixed.

In order to target interventions at those most likely to benefit from them (and most likely to consume services in the future), predictive models are often employed. However, in the interventions included in the review, few appeared to use multimorbidity as a predictor. In this second phase of the research, the significance of multimorbidity, complex multimorbidity, and disease-count are assessed in relation to healthcare use and mortality in a large cohort of people attending the emergency department. If significantly associated with these outcomes, the argument can be made that these variables should be used in predictive models aimed at reducing healthcare use or targeting palliative care interventions in people with multimorbidity.

The findings of this study were published in the Journal of Multimorbidity and Comorbidity in December 2022 (McParland et al., 2022a) – the article is included in Appendix 6. The findings presented here are consistent with the published manuscript.

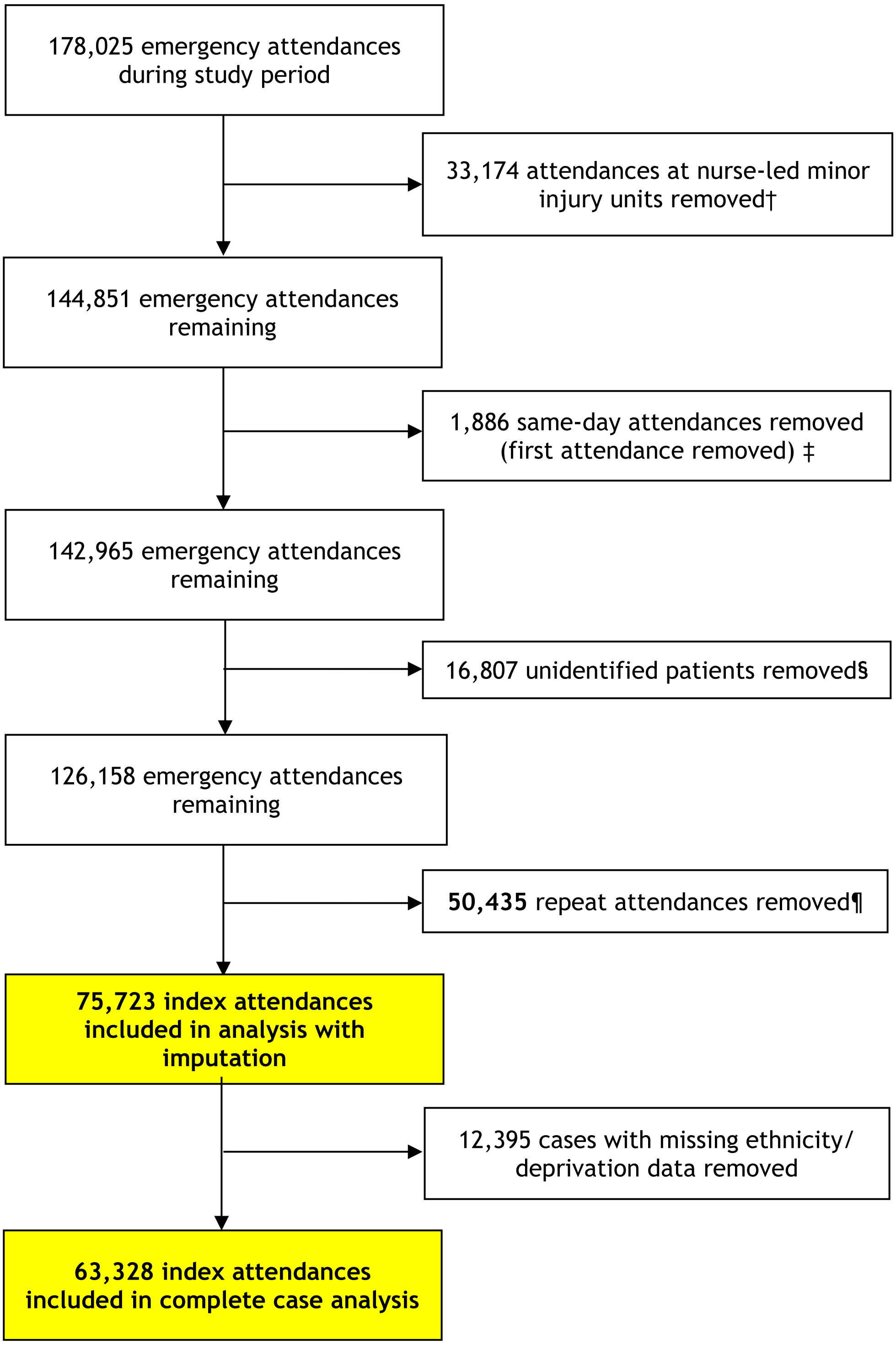
6.2 Description of sample

There were a total of 178,025 emergency attendances made by people residing in the Glasgow city area between 1st April 2019 and 31st March 2020. The way in which the final sample size of 63,328 individuals was arrived at is summarised in Figure 6-1. From the total, 33,174 attendances at nurse-led minor injury units were removed. These units cannot admit patients directly to hospital, so there is a null chance of these attendances resulting in any of the outcomes under investigation. In the event someone required admission to hospital they would be transferred to an emergency department where they would be listed as a new attendance and would, therefore, be included in the sample. A further 1,886 same-day attendances were removed; when an individual attends an emergency department and requires transfer to another emergency department (often for stroke thrombolysis, which is only provided at one hospital in the area) then they are normally registered as a new patient. Inclusion of these cases would result in artificial inflation of reattendance figures. In these cases, the initial attendance was removed as the second is most likely to represent the definitive care episode.

The Safe Haven platform makes use of a pseudonymised patient identifier to facilitate data linkage (in place of a patient CHI). Where this identifier is unavailable it is impossible to link the individual with inpatient data, therefore 16,807 unidentified patients were removed. Reasons for the absence of a patient identifier may include when someone is brought to the emergency department while unconscious, or when someone attends a Glasgow hospital while visiting from another health board or outside Scotland. In clinical practice a temporary identifier is assigned, but this does not necessarily translate to a pseudonymised identifier in the Safe Haven platform.

The unit of analysis in this study is individual patients – not individual attendances. For each patient attending during the 12-month period, the first attendance was used as the index attendance, and for the purpose of analysis variables were created to identify whether the individual reattended within 30 or 90 days. In order to satisfy the statistical assumption of independence required for logistic regression, the 50,435 repeat attendances were then removed.

From the remaining sample of 75,723, data were missing in 12,395 cases (16%), mostly ethnicity data (15.9%) and to a lesser extent SIMD (0.6%). The decision was taken to conduct a complete-case analysis on the remaining 63,328 cases, and to compare this qualitatively with results of a post-imputation analysis. The latter is detailed at the end of the chapter, the following sections outline the results of the complete-case analysis.



†Nurse-led minor injury units can not admit patients directly
‡In order to avoid inflation of reattendances when individuals were transferred between facilities
§Data-linkage can only be conducted on patients with a clinical identification number
¶First attendance used as index to calculate reattendance, statistical assumptions prevent repeated inclusion of the same case

Figure 6-1: Summary flow diagram of sample size. From McParland et al (2022).

6.2.1 Demographics

Table 6-1 provides a summary of the complete case sample, stratified by multimorbidity and complex multimorbidity. Around one-in-five people had multimorbidity (n=13,122, 20.7%), 39.3% of whom (n=5,157) also had complex multimorbidity (8.1% of total sample). There were slightly more women than men (54.2% vs 45.8%), and the sample was almost entirely white (n=59,056, 93.3%). Socioeconomic deprivation is strongly associated with multimorbidity, however the overall sample was predominantly in the lower SIMD deciles with a median of 2 (interquartile range (IQR) = 1-4). Figure 6-2 visualises the extent to which the sample skewed towards SIMD deciles one and two.

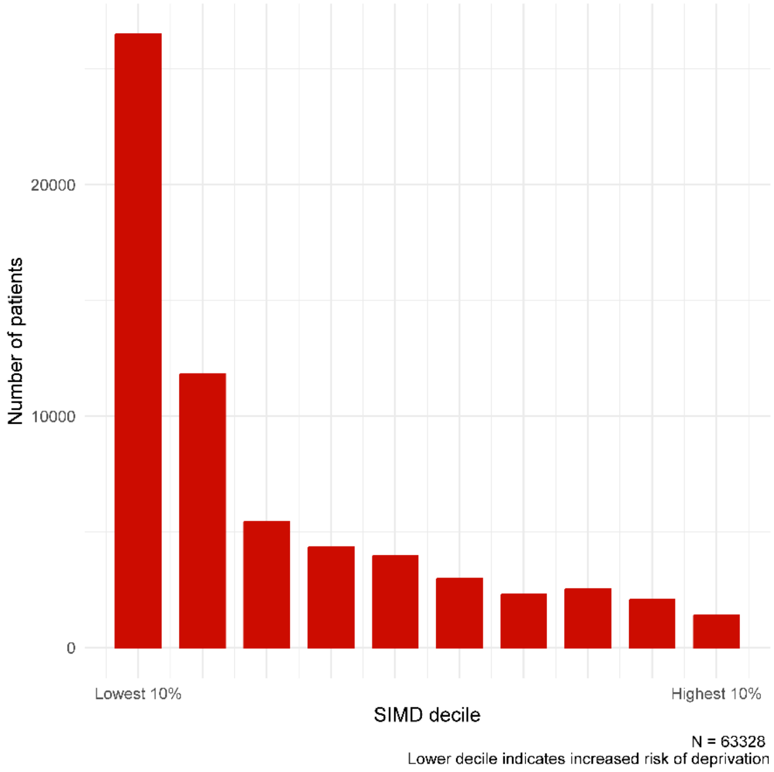


Figure 6-2: Summary of Scottish Index of Multiple Deprivation (SIMD) decile for complete case sample. From McParland et al (2022).

Of the 63,328 people attending the ED during the study period, 43.2% were admitted to hospital (n=27,362), 13.8% reattended within 30 days (n=8,530), 23.1% reattended within 90 days (n=14,659), and 3.8% of those who were admitted from the ED died during the admission (n=1,031).

Sample	Overall	Multimorbidity	No Multimorbidity	Complex Multimorbidity	No Complex Multimorbidity
n	63,328	13,122	50,206	5,157	58,171
Demographics:					
Male (%)	28,998 (45.8)	6,090 (46.4)	22,908 (45.6)	2,286 (44.3)	26,712 (45.9)
Female (%)	34,330 (54.2)	7,032 (53.6)	27,298 (54.4)	2,871 (55.7)	31,459 (54.1)
Age (median [IQR])	54 [36, 70]	71 [58, 81]	49 [33, 64]	73 [61, 81]	52 [35, 67]
Ethnicity:					
White	59,056 (93.3)	12,774 (97.3)	46,282 (92.2)	5,021 (97.4)	54,035 (92.9)
Asian	2,589 (4.1)	286 (2.2)	2,303 (4.6)	116 (2.2)	2,473 (4.3)
African	602 (1.0)	31 (0.2)	571 (1.1)	11 (0.2)	591 (1.0)
Mixed/multiple	655 (1.0)	18 (0.1)	637 (1.3)	X	X
Other	303 (0.5)	7 (0.1)	296 (0.6)	X	X
Arabic	89 (0.1)	X	X	X	X
Caribbean	34 (0.1)	X	X	X	X
SIMD decile (median [IQR])	2 [1, 4]	2 [1,4]	2 [1,4]	2 [1,4]	2 [1,4]
Healthcare use:					
Admitted (%)	27,362 (43.2)	10,058 (76.6)	17,304 (34.5)	4,084 (79.2)	23,278 (40.0)
Reattend <30 days (%)†	8,530 (13.8)	2,714 (22.7)	5,816 (11.8)	1,206 (24.6)	7,324 (12.9)
Reattend <90 days (%)‡	14,659 (23.1)	5,208 (42.5)	9,451 (19.3)	2,370 (49.4)	12,289 (21.8)
Total attendances (median [IQR])	1 [1, 2]	2 [1, 3]	1 [1, 2]	2 [1,3]	1 [1,2]
Mortality					
Died during admission (%)§	1,031 (3.8)	529 (5.3)	502 (2.9)	216 (5.3)	815 (3.5)
Died <30 days (%)¶	1,403 (2.2)	704 (5.4)	699 (1.4)	290 (5.6)	1,113 (1.9)
Died <6 months (%)¶	3,389 (5.4)	1,899 (14.5)	1,490 (3.0)	860 (16.7)	2,529 (4.3)
Died <12 months (%)¶	5,266 (8.3)	3,025 (23.1)	2,241 (4.5)	1,459 (28.3)	3,807 (6.5)

N=12,395 cases were excluded from complete-case analysis for missing ethnicity (15.9%) and SIMD (0.6%) data.
Low-count values (<5) and those which risk secondary identification are marked with an 'X'.
†Represents whether any reattendances occurred within 30 days of index attendance. Percentage calculation excludes those who had died without reattending or were still admitted.
‡ Represents whether any reattendances occurred within 90 days of index attendance. Includes reattendances within 30 days. Percentage calculation excludes those who had died without reattending or were still admitted.
§Percentage calculation based on admitted patients.
¶ Inpatient and outpatient mortality, inclusive of mortality at earlier timepoints where applicable.

Table 6-1: Summary of sample, stratified by multimorbidity and complex multimorbidity. Complete case analysis. From McParland et al (2022).

6.2.2 Chronic conditions

The most commonly-detected chronic conditions in the sample were chronic kidney disease (n=6,914, 10.9%), hypertension (n=5,818, 9.2%), chronic obstructive pulmonary disease (n=5,590, 8.8%), diabetes (n=4,591, 7.2%), and alcohol misuse (n=4,557, 7.2%). No chronic conditions were detected for the majority of the sample (n=38,409, 60.7%). Figure 6-3 and Table 6-2 summarise the frequency with which conditions were detected.

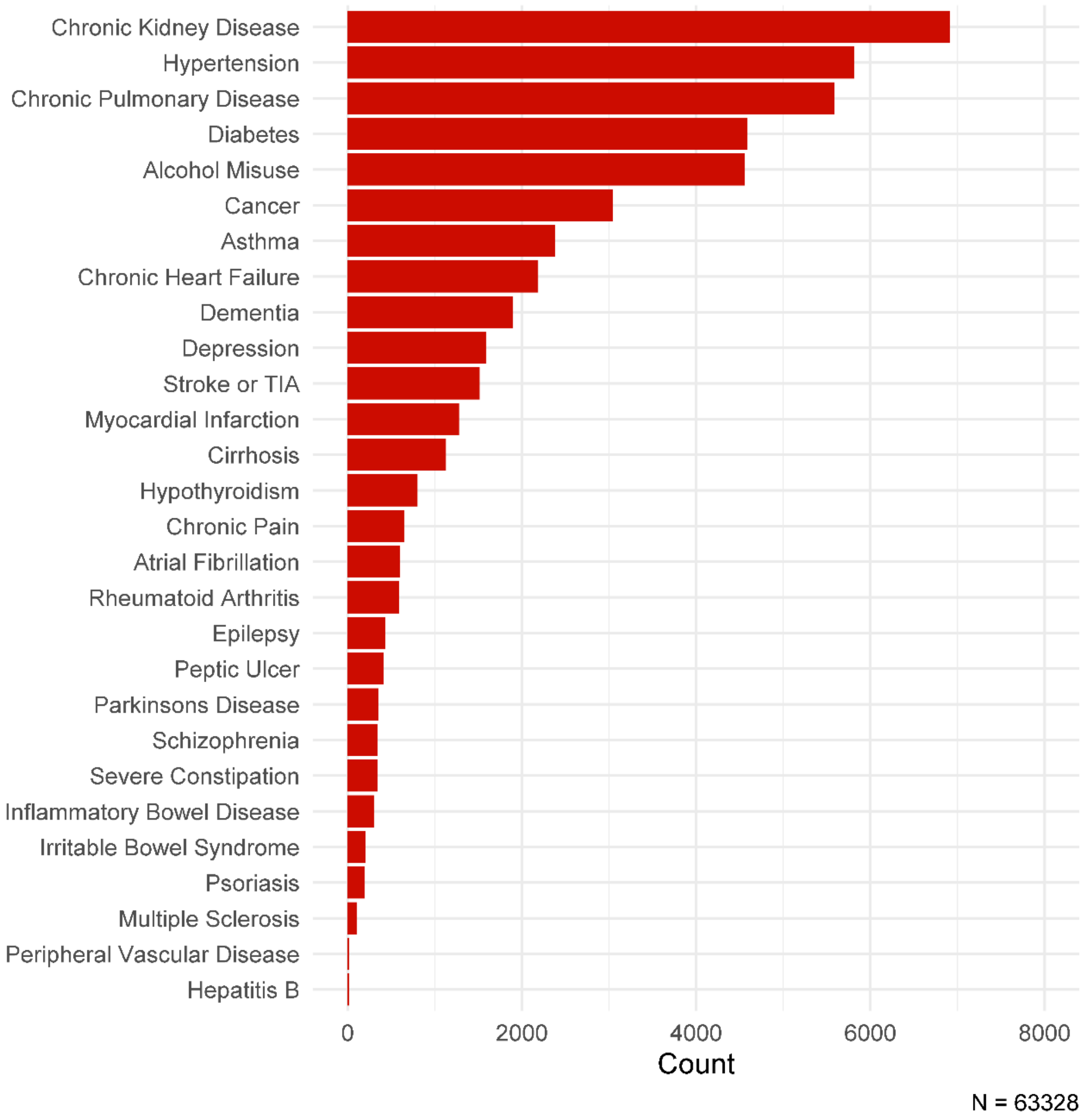


Figure 6-3: Frequency of detected chronic conditions. From McParland et al (2022).

Disease count	n	%
No chronic conditions	38,409	60.7
One chronic condition	11,797	18.6
Two chronic conditions	6,888	10.9
Three chronic conditions	3,754	5.9
Four chronic conditions	1,645	2.6
Five chronic conditions	605	1.0
6 or more conditions	230	0.4

Conditions by frequency and percentage affected

Disease	n	%	Disease	n	%
1. Chronic kidney disease	6914	(10.9)	15. Chronic pain	655	(1.0)
2. Hypertension	5818	(9.2)	16. Atrial fibrillation	601	(0.9)
3. Chronic pulmonary disease	5590	(8.8)	17. Rheumatoid arthritis	594	(0.9)
4. Diabetes	4591	(7.2)	18. Epilepsy	436	(0.7)
5. Alcohol misuse	4557	(7.2)	19. Peptic ulcer disease	412	(0.7)
6. Cancer	3048	(4.8)	20. Parkinson’s disease	352	(0.6)
7. Asthma	2378	(3.8)	21. Schizophrenia	344	(0.5)
8. Chronic heart failure	2190	(3.5)	22. Severe constipation	341	(0.5)
9. Dementia	1896	(3.0)	23. Inflammatory bowel disease	305	(0.5)
10. Depression	1590	(2.5)	24. Irritable bowel syndrome	206	(0.3)
11. Stroke or Transient Ischaemic Attack (TIA)	1517	(2.4)	25. Psoriasis	200	(0.3)
12. Myocardial infarction	1281	(2.0)	26. Multiple sclerosis	109	(0.2)
13. Cirrhosis	1131	(1.8)	27. Peripheral vascular disease	18	(0.2)
14. Hypothyroidism	803	(1.3)	28. Chronic viral hepatitis B	15	(0.2)

Table 6-2: Frequency and burden of detected chronic conditions. From McParland et al (2022).

6.3 The significance of multimorbidity, complex multimorbidity and disease-count in relation to negative outcomes

Having described the sample, this section will outline the results of the adjusted logistic regression models in relation to the four co-primary outcomes: admission to hospital, reattendance at the ED within 30 days, reattendance within 90 days, and death during admission. Summaries of all adjusted and unadjusted models are available for complete case analyses in Appendix 13 and for post-imputation analyses in Appendix 14.

6.3.1 Admission to hospital from the emergency department

Adjusting for age, sex, deprivation (SIMD) and ethnicity, there was a significant association between multimorbidity and admission to the hospital from the ED (OR: 4.15, 95% CI: 3.96-4.36). There was also a significant association between complex multimorbidity and admission (OR: 3.41, 95% CI: 3.17-3.66). Having any number of chronic conditions was significantly associated with admission, and the strength of association increased in a broadly linear manner from one condition (OR: 5.04, 95% CI: 4.81-5.27) to six or more conditions (OR: 14.31, 95% CI: 9.79-21.76). The association between multimorbidity, complex multimorbidity, disease count and admission is summarised in Figure 6-4.

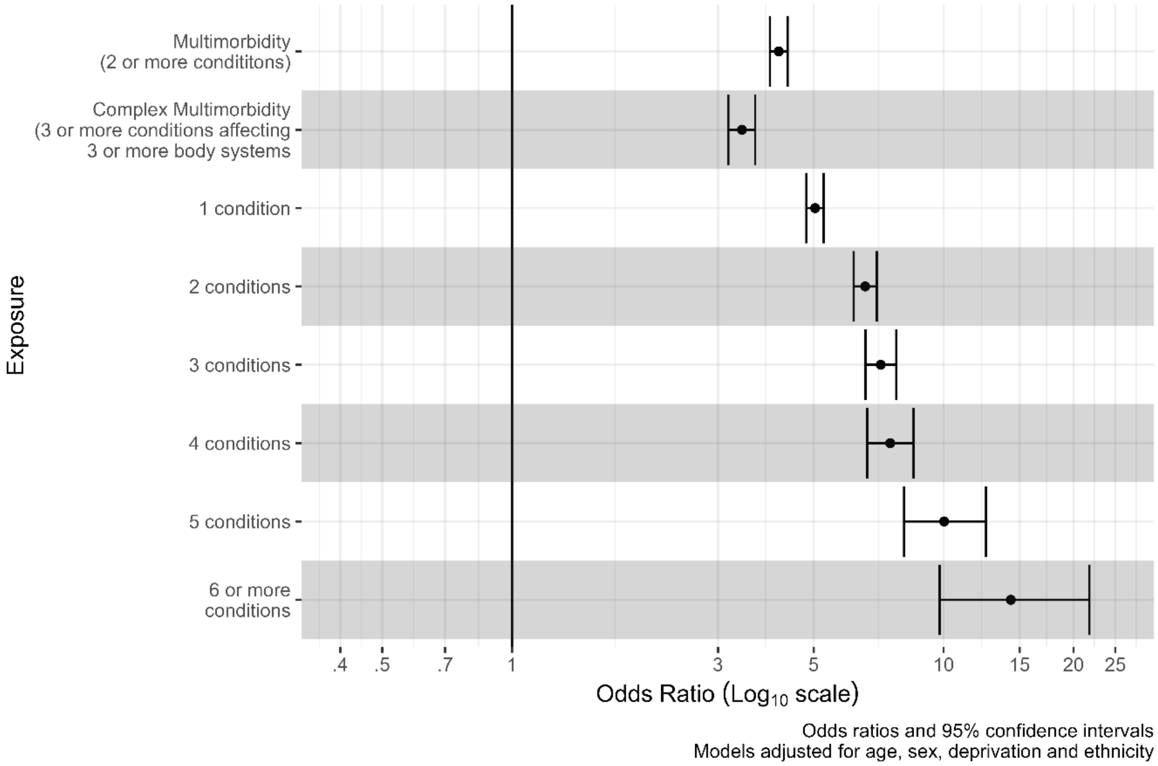


Figure 6-4: The association between multimorbidity, complex multimorbidity, disease-count and admission to hospital from the emergency department. N=63,328. From McParland et al, (2022).

6.3.2 Reattendance at the emergency department within 30 days

In order to explore the association between the exposures and reattendance at the ED within 30 days, it was necessary to exclude all those from the sample who died within 30 days of reattendance, or who were still admitted to the hospital 30 days after their initial attendance. This resulted in a sample of n=61,775

Again, both multimorbidity (OR: 2.21, 95% CI: 2.09-2.34) and complex multimorbidity (OR: 2.20, 95% CI: 2.04-2.37) were significantly associated with 30-day reattendance. The risk was significant at any level of disease-burden, ranging from one condition (OR: 1.99, 95% CI: 1.87-2.11) to six or more conditions (OR: 4.76, 95% CI: 3.54-6.34). Figure 6-5 provides an overview of effect sizes.

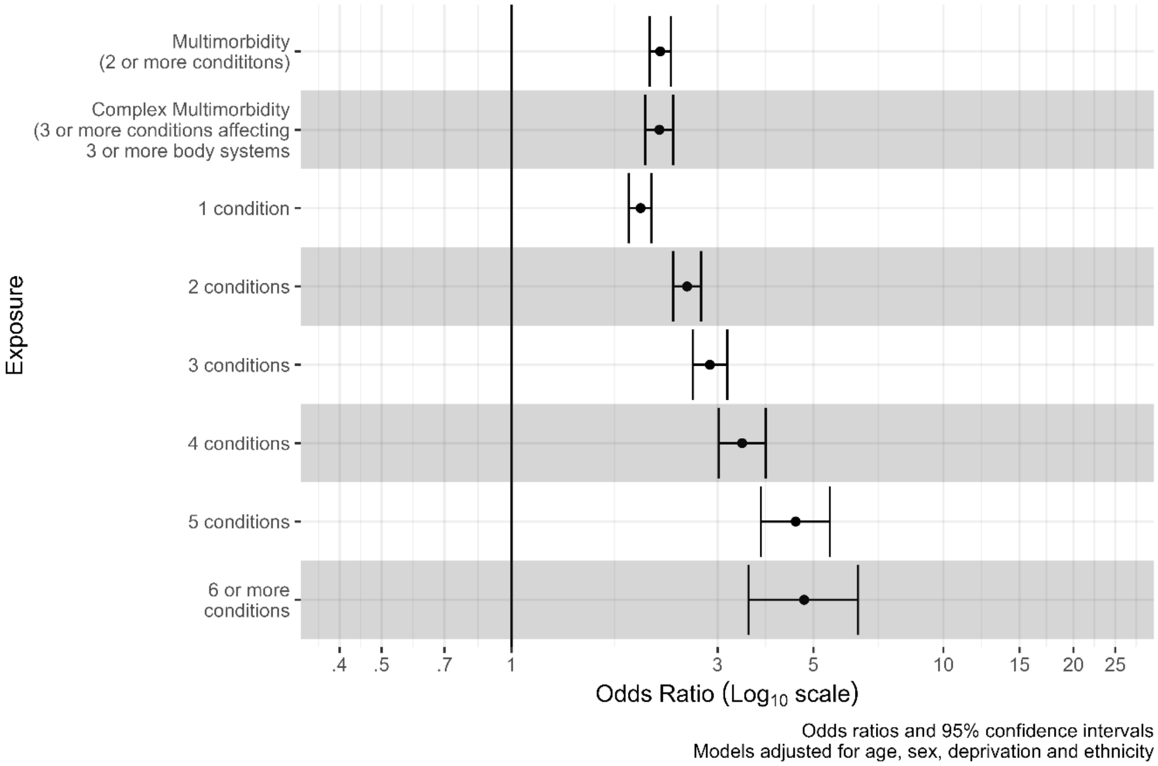


Figure 6-5:The association between multimorbidity, complex multimorbidity, disease-count and 30-day reattendance at the emergency department. N=61,775. From McParland et al, (2022).

6.3.3 Reattendance at the emergency department within 90 days

As with the preceding analysis, it was necessary to remove any cases where the patient had died within 90 days of the index attendance at the ED, and those who were still admitted at this time-point. This resulted in a sample of n=61,241.

Multimorbidity (OR: 3.11, 95% CI: 2.96-3.26), complex multimorbidity (OR: 3.21, 95% CI: 3.01-3.41) and disease count were again significantly associated with 90-day reattendance. The risk increased in a linear manner with increasing number of diseases (OR: 10.79, 95% CI: 8.18-14.12 for those with six or more conditions), and the effect sizes were consistently higher than those noted for 30-day reattendance. Figure 6-6 summarises the effect sizes.

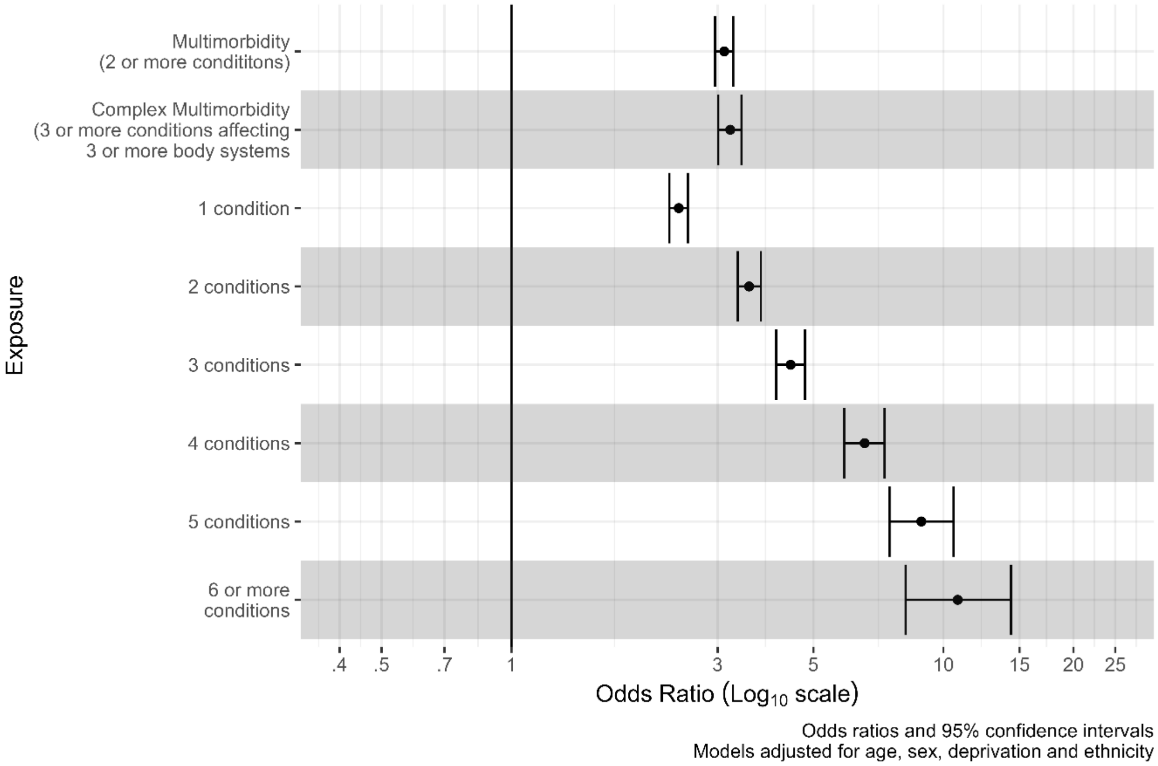


Figure 6-6:The association between multimorbidity, complex multimorbidity, disease-count and 90-day reattendance at the emergency department. N=61,241. From McParland et al, (2022).

6.3.4 Inpatient mortality

The final outcome to be explored is inpatient mortality. For this analysis, the sample was restricted to those who were admitted to hospital (n=27,361, 43.2% of total sample). The first attempted analysis was confounded by issues with complete separation. Due to low counts of some ethnic groups in the sample, none experienced the outcome (i.e. death during admission). Therefore, the model assigns a perfect value of zero to the probability of cases with this exposure (i.e. members of specific ethnic groups) experiencing the outcome. In order to resolve this issue, five ethnic groups (African, Mixed/multiple, Other, Arabic, Caribbean) had to be collapsed into a single group, resulting in three categories (White, Asian, and Other).

Neither multimorbidity (OR: 1.13, 95% CI: 1.00-1.29) nor complex multimorbidity (OR: 0.99, 95% CI: 0.85-1.16) were significantly associated with inpatient mortality in the adjusted analysis. There were very small associations detected in unadjusted analyses for multimorbidity (OR: 1.86, 95% CI: 1.64-2.11), complex multimorbidity (OR: 1.56, 95% CI: 1.34-1.81), and all levels of disease-burden except those with six or more conditions. In the adjusted analysis, there was a significant association for those with one (OR: 1.81, 95% CI: 1.49-2.20), two (OR: 1.78, 95% CI: 1.46-2.18), or three conditions (OR: 1.76, 95% CI: 1.41-2.21), but not four (OR: 1.24, 95% CI: 0.90-1.68), five (OR: 0.91, 95% CI: 0.52-1.47), or six or more (OR: 0.98, 95% CI: 0.41-1.96). Figure 6-7 provides a summary of effect sizes in the adjusted analyses.

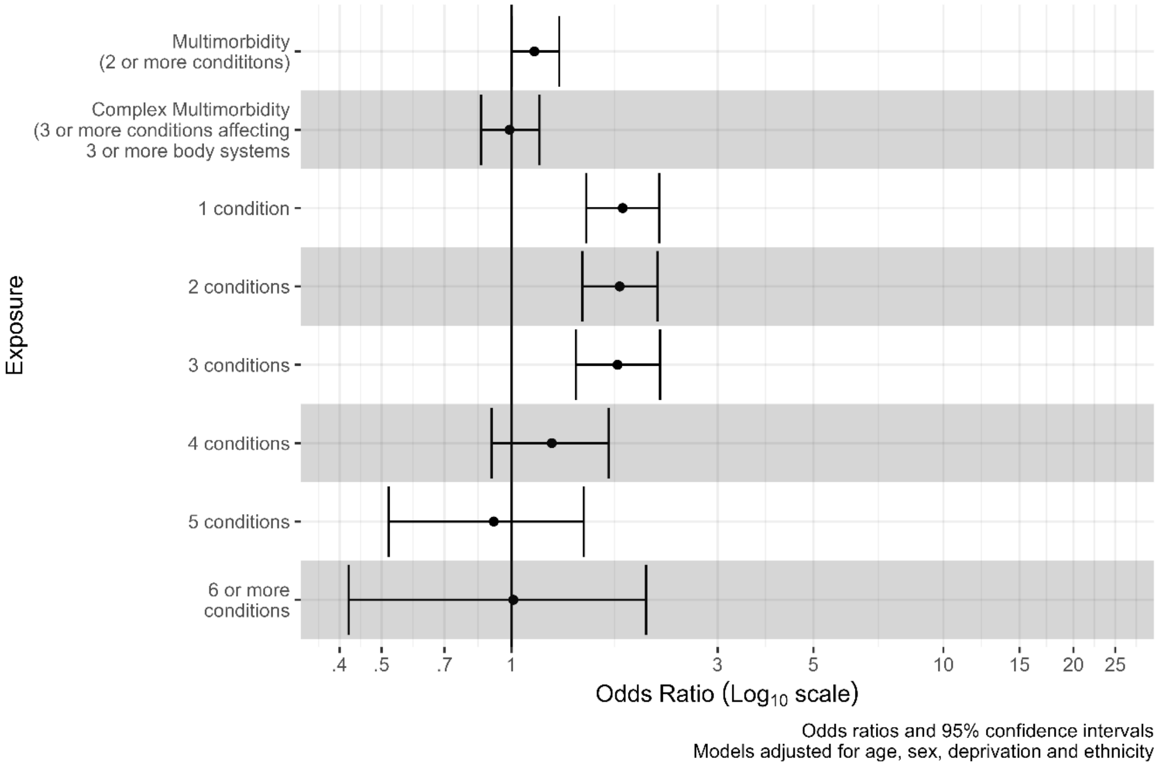


Figure 6-7: The association between multimorbidity, complex multimorbidity, disease-count and inpatient mortality for emergency attenders. N=27,361. From McParland et al, (2022).

6.4 Comparison with post-imputation analyses

As stated earlier, missing data were imputed in order to allow analyses to be conducted for all 75,723 cases. A random forest classification algorithm (Stekhoven and Buhlmann, 2012) was used to impute ethnicity data (missing in 15.9% of cases). A summary of the number and proportion of cases classified is in

Figure 6-8 and Figure 6-9. As only 0.6% of cases were missing SIMD data, the median value was imputed.

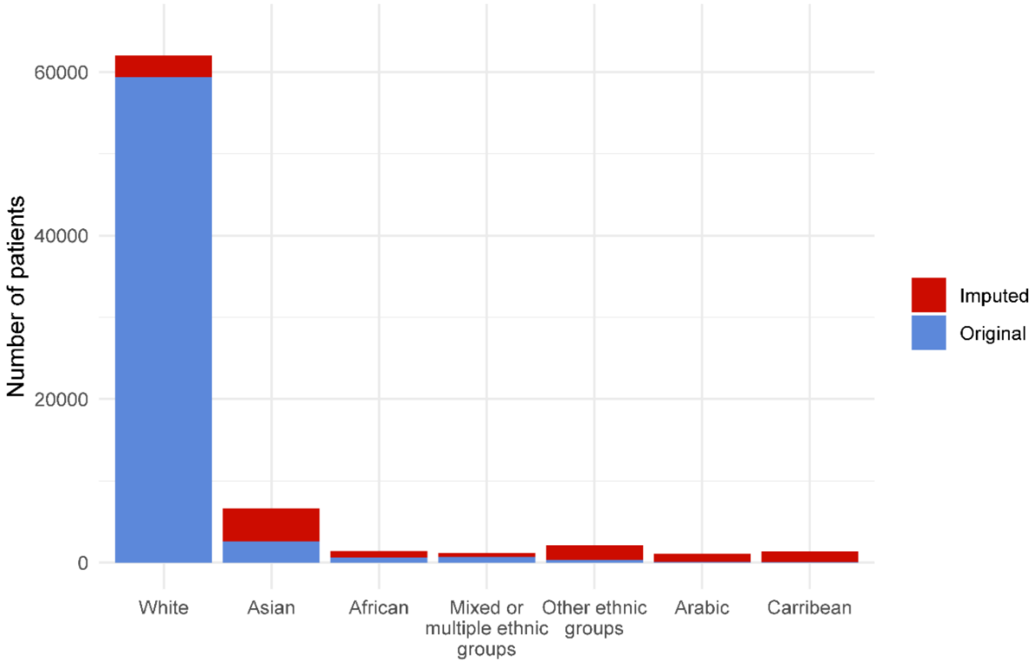
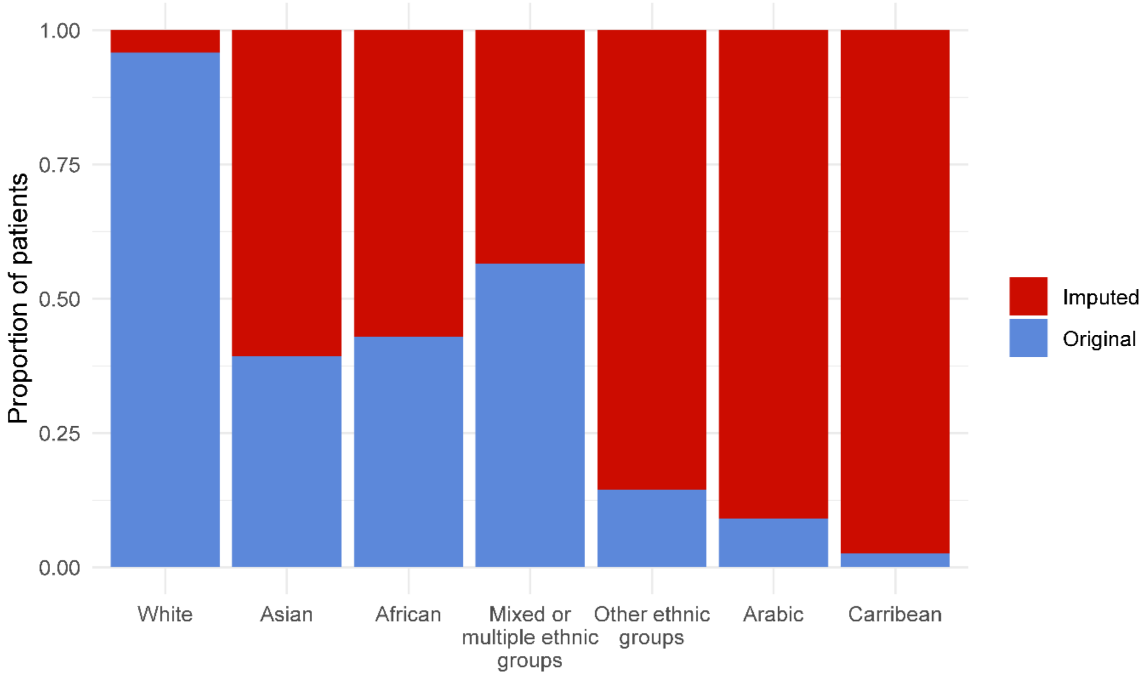


Figure 6-8: Distribution of imputed ethnicity data. From McParland et al, (2022).



Comparison by proportion imputed
Ethnicity summarised as per standardised groups used in inpatient records.

Figure 6-9: Proportion of imputed ethnicities. From McParland et al, (2022).

In order to establish whether there were any significant differences between the complete case and post-imputation analyses, the exact same process was followed for all outcomes as outlined in the preceding sections (including collapsing ethnicity categories in the inpatient mortality analysis. The results for each exposure and outcome were then assessed for any changes in effect size or direction which would affect the interpretation of results. There were no changes noted. A summary of the results of both complete case and post-imputation analyses is outlined in Table 6-3.

		Admission OR (95% CI)	30-day reattendance OR (95% CI)	90-day reattendance OR (95% CI)	Inpatient mortality OR (95% CI)
Multimorbidity	Complete cases	4.15 (3.96-4.35)	2.21 (2.09-2.34)	3.11 (2.96-3.26)	1.13 p=0.057 (1.00-1.29)
	Imputed data	4.22 (4.03-4.42)	2.18 (2.07-2.31)	3.11 (2.97-3.25)	0.97 p=0.743 (0.83-1.13)
Complex multimorbidity	Complete cases	3.41 (3.17-3.66)	2.20 (2.04-2.37)	3.21 (3.01-3.41)	0.99 p=0.915 (0.85-1.16)
	Imputed data	3.45 (3.22-3.70)	2.22 (2.07-2.39)	3.27 (3.08-3.48)	0.97 p=0.743 (0.83-1.13)
1 condition	Complete cases	5.04 (4.81-5.27)	1.99 (1.87-2.11)	2.44 (2.32-2.56)	1.81 (1.49-2.20)
	Imputed data	5.38 (5.14-5.62)	1.94 (1.83-2.06)	2.41 (2.29-2.53)	1.84 (1.53-2.22)
2 conditions	Complete cases	6.58 (6.19-7.00)	2.55 (2.37-2.75)	3.55 (3.34-3.78)	1.78 (1.46-2.18)
	Imputed data	6.84 (6.45-7.27)	2.48 (2.31-2.66)	3.49 (3.29-3.71)	1.81 (1.49-2.20)
3 conditions	Complete cases	7.15 (6.59-7.77)	2.88 (2.63-3.16)	4.43 (4.10-4.78)	1.76 (1.41-2.21)
	Imputed data	7.27 (6.71-7.89)	2.81 (2.57-3.07)	4.37 (4.05-4.71)	1.77 (1.43-2.20)
4 conditions	Complete cases	7.52 (6.65-8.52)	3.42 (3.02-3.88)	6.57 (5.89-7.31)	1.24 p=0.180 (0.90-1.68)
	Imputed data	7.62 (6.76-8.60)	3.39 (3.00-3.83)	6.68 (6.01-7.42)	1.30 p=0.083 (0.96-1.74)
5 conditions	Complete cases	10.03 (8.10-12.54)	4.55 (3.78-5.46)	8.89 (7.50-10.56)	0.91 p=0.710 (0.52-1.47)
	Imputed data	10.60 (8.60-13.18)	4.51 (3.77-5.37)	8.97 (7.61-10.59)	0.86 p=0.557 (0.50-1.39)
6+ conditions	Complete cases	14.31 (9.79-21.76)	4.76 (3.54-6.34)	10.79 (8.18-14.34)	1.01 p=0.973 (0.42-2.05)
	Imputed data	14.04 (9.76-20.91)	4.62 (3.46-6.11)	10.71 (8.18-14.12)	0.98 p=0.949 (0.41-1.96)

Non-significant findings are highlighted in grey.
All models adjusted for age, sex, deprivation and ethnicity.
All p<0.001 except where specified.
No differences were noted in direction of association between complete case and imputed analyses for any combination of exposure and outcome.

Table 6-3: Comparison of effect sizes for complete case and post-imputation analyses. From McParland et al, (2022).

6.5 Chapter summary

This chapter has described the findings of a cross-sectional study of ED attenders in the Glasgow city area, which sought to establish whether there were significant associations between multimorbidity, complex multimorbidity, disease-count, and negative outcomes (healthcare use and inpatient mortality). All exposures were significantly associated with admission and reattendance at both 30 and 90 days after the index attendance. The strength of these associations was broadly linear, in the sense that having more conditions meant increased risk. There was no significant association between multimorbidity or complex multimorbidity and inpatient mortality, although the association was significant for people with one, two or three conditions.

In the first phase of the research, it was noted that predictive modelling and risk stratification algorithms were frequently used to identify populations with multimorbidity who may benefit from intervention. In this chapter, it has been demonstrated that validated algorithms for the detection of 28 chronic conditions using ICD-10 codes can be deployed on routinely-collected data, and that they can detect significant associations between multimorbidity and future healthcare use. It has provided a proof-of-concept that these exposures should be considered when building predictive models for targeted multimorbidity interventions. In the final phase of the research, the focus will move to the patient perspective. For an intervention to succeed, it must be acceptable to patients and carers; the next chapter presents findings from a focussed ethnographic study which seeks to explore the way patients and carers experience treatment burden, and to identify ways in which services can be designed with this important concept in mind.

Chapter 7. Focussed ethnography findings (EMBARQUE study)

7.1 Introduction

In the first phase of this research programme, the findings of a mixed methods systematic review provided a framework through which the types of nurse-led interventions for people with multimorbidity can be understood. In the second phase, a cross-sectional analysis of routinely-collected healthcare data provided evidence of the association between multimorbidity and unscheduled care use in a population of ED attenders. In this third and final phase, the findings are outlined from a focussed ethnographic study of people with multimorbidity and palliative conditions (cancer, chronic obstructive pulmonary disease (COPD), chronic heart failure (CHF), chronic kidney disease (CKD), and dementia) and their carers.

The study aimed to explore how people with multimorbidity and their carers experience burden of treatment, as described by May et al. (2014). There were three specific objectives:

1. To identify common healthcare tasks and responsibilities which are perceived as burdensome by people with multimorbidity and their carers.

2. To identify priorities for improving care for people with multimorbidity in order to reduce treatment burden.

3. To explore the role of carers in supporting people with multimorbidity, and to understand the ways in which they currently help to alleviate treatment burden.

In the first section, a relational typology is discussed which provides a means of understanding the shape and dynamics of the relational networks of people with multimorbidity. In the second section, Burden of Treatment Theory is described in the context of this study, with examples from the data. In the final section, the overarching theme of ‘uncertainty’ is uncovered, and linked to both Burden of Treatment Theory and other micro-range theories related to the concepts of total uncertainty (Etkind et al., 2022) and uncertainty tolerance (Hillen et al., 2017).

This phase of the thesis adopted a focussed ethnographic approach, which differs from a classical ethnographic approach in several ways. Particular differences include short-term engagement with a relatively small sample, limited interaction between participants, and a significantly reduced emphasis on direct observation (Wall, 2015; Higginbottom et al., 2013).

In the absence of prolonged observation, it was important to ensure multiple alternative sources of data were available to avoid relying solely on interviews. These sources of information were as follows:

- Interview recordings and transcripts (two interviews were planned per patient/carer dyad).

- Treatment burden journals: free-form journals kept by participants throughout the study, in which they were encouraged to document burdensome experiences.

- Field notes which were made when visiting participants or observing burdensome tasks

- Reflexive journal entries kept by the researcher. These were completed within 24 hours of any study procedure (such as interviews), in response to any significant correspondence or event, and at key stages in the analytical process.

7.1.1 Participants

All participants were recruited by the researcher from the emergency department, as outlined earlier in the thesis. Six patient-carer dyads were recruited (n=12 participants). Participant understanding of specific diagnoses was varied, so a definitive list of chronic conditions is not presented here. All participants had at least one of the index conditions and at least one other condition. Several carers also met the inclusion criteria as patients. Pseudonyms are used for the preservation of confidentiality. A short synopsis of the six dyads follows:

Mel and Scott are a married couple. Mel has multiple cardiac, respiratory, renal and psychiatric conditions. Scott also takes regular medications and is Mel's primary carer. Mel attended the ED with a respiratory illness and was discharged shortly after. [Patient age 50-60]

Tom and Ruth are a married couple, both of whom had multiple conditions including cardiac, respiratory and endocrine conditions. Ruth was also undergoing treatment for cancer. They live together and have support from family members who live nearby. Tom attended the ED after a fall and was discharged the same day. [Patient age 70-80]

Andy is the primary carer for his mother, **Patricia.** Patricia has respiratory, gastrointestinal, cardiac and pain-related conditions, as well as cancer for which she was no longer undergoing treatment. Andy lives with Patricia, and also has multiple conditions including orthopaedic and pain-related conditions. Andy and Patricia have family who live both at the same address and nearby. Andy has power of attorney for Patricia and deals with her legal affairs. Patricia attended the ED after sustaining a fractured arm in a fall at home. Both Patricia and Andy were keen for her to return home, and she was discharged the same day after treatment. [Patient age 70-80]

Barbara lives alone in retirement accommodation and her primary carer is her friend **Theresa,** who lives in the same building. Barbara has multiple conditions including cardiac and gastrointestinal conditions. Barbara's and Theresa's families are both in regular contact with them but most live a considerable distance from them, many in different parts of the UK. Barbara attended the ED with an acute viral illness which required a period of admission. [Patient age 80-90]

Nick is cared for at home by his mother **Stephanie** and her husband, Nick's father. Nick has multiple conditions including previous cancer, neurological, and respiratory conditions. Stephanie is a healthcare professional and provides daily basic care to Nick at home. Nick has severely limited communication and

Stephanie is his legal guardian. Nick attended the ED with an acute respiratory infection but was able to be discharged in the care of Stephanie the same day. [Patient age 20-30]

Bill and Irene are a married couple. Bill has multiple chronic conditions including cardiac and respiratory conditions. He is also undergoing treatment for cancer. Bill and Irene have some family support nearby and have good relationships with their friends and neighbours, having lived in the same area for many years. Bill attended the ED following a seizure and required a period of admission. [Patient age 70-80]

A total of 11 interviews were conducted (with just over 11 hours of recorded conversation), and six diaries were received (one dyad didn't return theirs and another completed one each). Only one formal observation session took place; some of the ideas proposed by participants (such as visiting hospital wards) would not have been permitted without securing further ethical approvals. As is required in reflexive thematic analysis, a researcher-completed reflexive diary was also kept; a total of 14 entries were made.

One dyad (Mel and Scott) were lost to follow-up after the first interview and a short period of correspondence.

7.2 Mapping the flow of support between members of relational networks: a relational typology

Burden of Treatment Theory is concerned with the way that agency and capacity are mobilised and expressed by people with multimorbidity and their relational networks in order to undertake the delegated tasks which comprise the work of patienthood (May et al., 2014). Therefore, prior to exploring how the theory can be applied in the context of this this study, it is important to undertake some mapping of the types of relational networks encountered. Presented here is a typology of relational networks which can be used to categorise the way in which support flows between individuals.

The first point to address is the assumed dichotomy between the role of ‘patient’ and ‘carer’. Many of those recruited to the study as a patient were also involved in providing care to the person recruited to the study as a carer. Therefore, when either term is used in this chapter it does not preclude someone occupying the opposite role either concurrently or in the past and/or future.

As is the case with Burden of Treatment Theory, this typology represents a dynamic set of structures in which the flow of support and the occupation of patient and carer roles can (and most likely will) shift in response to changes in health status or biographical disruptions. Therefore, a carer may find themselves adopting the role of patient as a result of illness or injury, with the prior recipient of their care now providing support.

The relational network can be divided into two tiers. The first ‘primary’ tier of the relational network comprises the patient(s) and the person(s) who are involved in the daily work of caring for and supporting someone with multimorbidity. Often the membership of this tier will live together, although this is not a requirement. Often they are spouses, parents, children or close friends.

The ‘secondary’ tier of the relational network is made up of the people who can provide support to the patient and members of the primary tier when required, often the extended family, friends and/or neighbours. They may be active in this role, for example by calling and visiting frequently or performing infrequent but predictable tasks (such as delivering shopping or helping with occasional housework). They may also be passive in this role, necessitating that members of the primary network call upon them for support, acting as a safety-net which due to the strength of relational bonds can be relied upon to help when needed.

The membership of this secondary tier can also be 172ategoryised as proximal or distal. The distance assumed by this concept is not simply geographical, but encompasses other factors which affect the readiness with which support can flow from the secondary to primary tier when called upon. For example, it may be easier to activate a member of the secondary tier who lives far away but has few commitments and access to a car, than to enlist the support of someone who stays in the same city but has work commitments and relies upon public transport. Distance is a multidimensional measure of overall accessibility.

7.2.1 The primary relational network

In considering the network members responsible for the routine support of someone with multimorbidity, one must return to the dichotomy between patient and carer in its binary form. In a simple dyadic relationship (Figure 7-1), one person is the patient and one person is the carer. Support (denoted by the arrow) flows from the carer to the patient.

Figure 7-1: Simple dyadic primary network

To provide an example, Barbara is in her 80s and lives alone since the death of her husband; she has adult children who live far away. Barbara's close friend Theresa lives in the same building as her, and she provides help and support to Barbara by checking on her regularly, doing errands when needed and keeping Barbara company. The relationship between Barbara and Theresa could be described as a simple dyadic one, in which Barbara occupies the role of the patient, and Theresa is the carer.

In many relationships, it is difficult to delineate between who is a patient and who is a carer. The flow of support is often reciprocated, either fully or partially. In a reciprocal dyadic relationship (Figure 7-2), both members are involved in supporting one another and the level of support is more or less equal. Tom and Ruth are such an example. A married couple in their 70s, they both have multiple chronic conditions, take multiple medications and are under the care of various specialties. They help one another remember their medication and drive one another to appointments. In an unequal dyadic relationship (Figure 7-2), support does flow both ways, but is unevenly distributed. The unequal distribution of support does not indicate inattentiveness but may be attributed to one member having greater need for support than the other, or one member being unable to provide the same level of support due to their own health or a lack of capacity to do so. Mel and her husband Scott's relationship is reciprocal to the extent that they help organise one another's medications and share in the administrative work of accessing healthcare. However, due to Mel's poor health Scott drives her to the hospital and to appointments, collects medications from the pharmacy, and visits Mel frequently when she is In the hospital. In this respect, the relationship skews towards Scott occupying the role of carer, although with Mel providing care for Scott to the extent that her health allows her.

Figure 7-2: Reciprocal dyadic and unequal dyadic primary networks

The above examples assume a dyadic primary relational network, although the case may also be that three or more (often cohabitant) individuals are engaged in the act of caring for one another. This polyadic relationship is by necessity complex as care may flow from one member to another bidirectionally, or there may be more clearly defined patient/carer roles. Furthermore, the level of support offered between members may vary dependant on the needs and capacity of individuals. Figure 7-3 shows a complex polyadic primary network in which three individuals are involved in providing reciprocal and equally distributed care to one another. Patricia (in her 70s) and her adult son Andy are part of a complex primary network such as this. Patricia is no longer receiving treatment for her cancer and is mostly bed-bound. Andy (who also has multiple conditions) lives nearby but mostly stays at Patricia's house, acting as her full-time carer. Patricia's daughter also lives with her, and she also assists by collecting medication from the pharmacy and spending lots of time with

Patricia. However, she also has health and social care needs which both Andy and Patricia support her with. In this relationship, all network members occupy both patient and carer roles to differing extents, and the flow of support is mostly bidirectional.

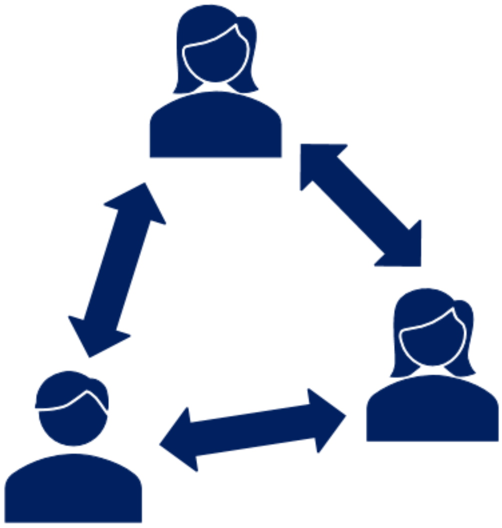


Figure 7-3: Complex polyadic primary network

There is also a subcategory of complex polyadic network which merits individual attention. There are cases in which one person is cared for by multiple individuals at the primary level, and this complex nucleated structure is represented in Figure 7-4. For example, Stephanie provides care to her son Nick, who is in his 20s and has had complex health needs and multiple chronic conditions since infancy. However, Stephanie's husband (Nick's father) is also involved in this primary network, as is Nick's adult brother, to differing extents. This relationship is characterised by a unidirectional flow of support towards Nick, who forms the nucleus of this network.

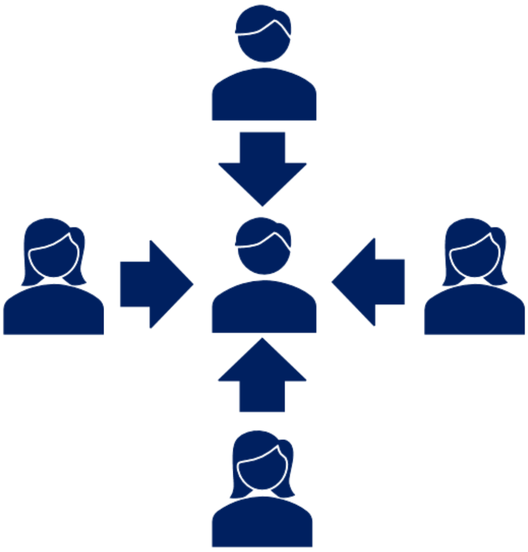


Figure 7-4: Complex nucleated primary network

At the primary level, there is one final structure to be considered. Owing to the inclusion criteria of this study (requiring both a patient and carer) there were no cases where individuals could be described as isolated (Figure 7-5). However, such persons are undoubtedly affected by multimorbidity and it is important to acknowledge them within this typology.

Figure 7-5: Isolated patient; an individual with no other members of the primary relational network

Figure 7-6 provides a summary of the six categories within the typology of primary relational networks.

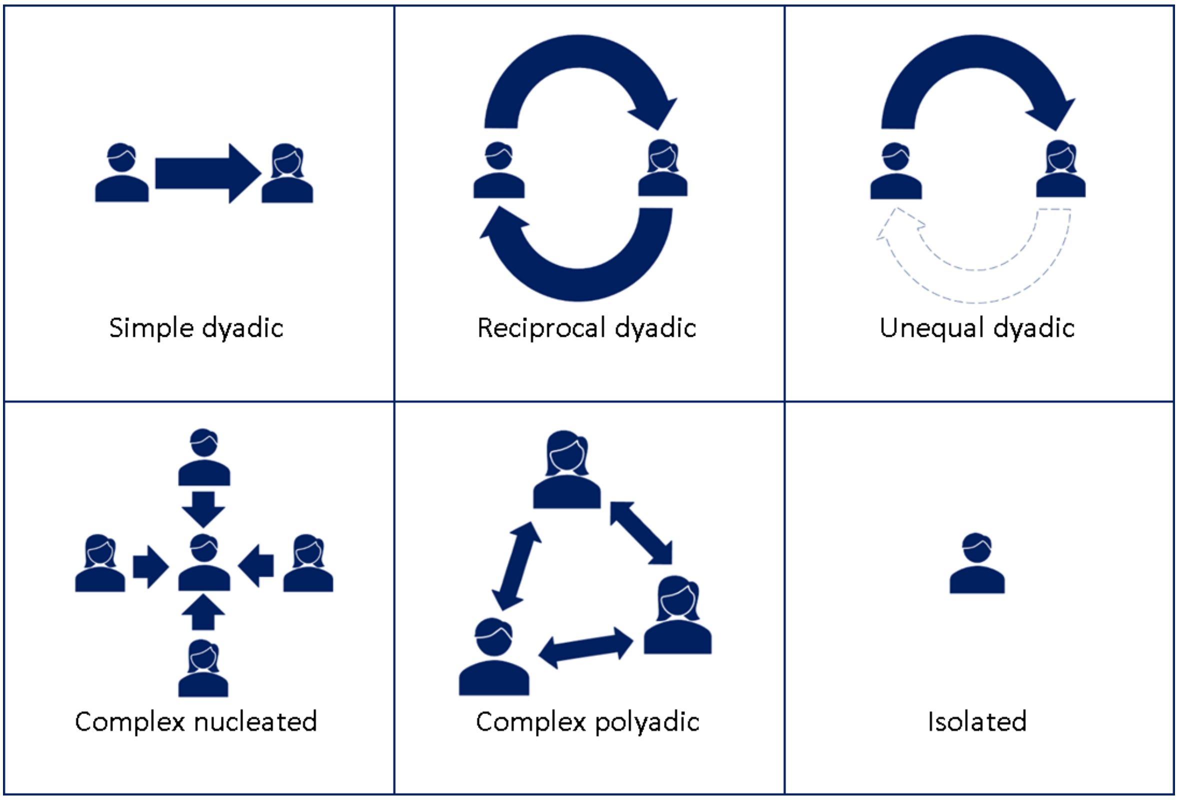


Figure 7-6: Typology of primary relational networks

7.2.2 Secondary relational networks

The secondary tier of relational network members (often friends, extended family or neighbours) can be characterised by their level of engagement with the primary network and their proximity to it. Having already described the characteristics which allow for classification as active/passive and proximal/distal, it simply remains here to outline that there are four permutations of secondary network which can be theorised (Figure 7-7).

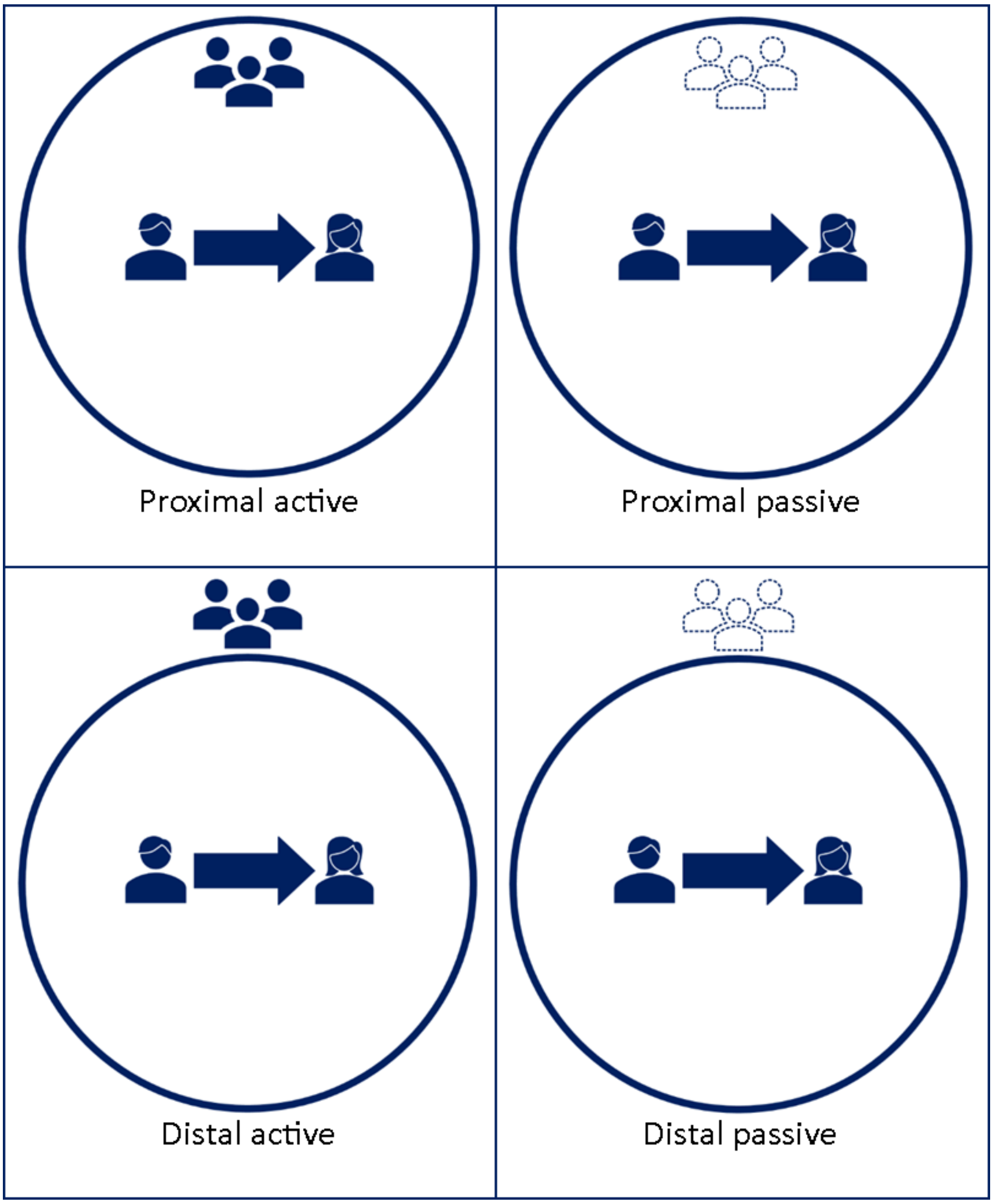


Figure 7-7: Typology of secondary relational networks. Illustrated in support of a simple dyadic primary network.

Proximity and passivity are not mutually exclusive, neither is being distant yet active. It is possible for secondary network members to have easy access to the primary network, yet to be passive in the type of support offered. Likewise, distant relatives and friends can still be actively engaged in supporting members of the primary network by keeping in touch and checking on them despite the geographical or practical distance that separates them.

Barbara's secondary relational network provides an example of this; her sons live in another part of the UK but call her regularly and visit her every month. When she was hospitalised, they would rearrange work commitments and travel to

Scotland to visit her and stay with her during her recovery. Despite the significant geographical distance between them, they were still very active in supporting her. Conversely, Patricia and Andy's close relatives lived nearby but both commented on how they were unable to rely on them for support. In this case they could be considered proximal and passive.

7.3 The treatment burden experience of people with multimorbidity and their carers: Burden of Treatment Theory

The preceding section provides a framework through which the relational network of patients and carers can be conceptualised. In this section, a description will be provided of how these networks mobilise and express capacity to undertake the work of patienthood, by mapping the findings of the study onto four generative mechanisms provided by Burden of Treatment Theory. These mechanisms are mobilising capacity, expressing capacity, mobilising for delegated tasks, and enacting delegated tasks.

7.3.1 Mobilising capacity

The first domain of Burden of Treatment Theory which will be explored relates to the agency of persons to undertake work, the extension of such agency through relational networks, and the ways in which it is shaped and constrained through the way healthcare services are structured (Figure 7-8).

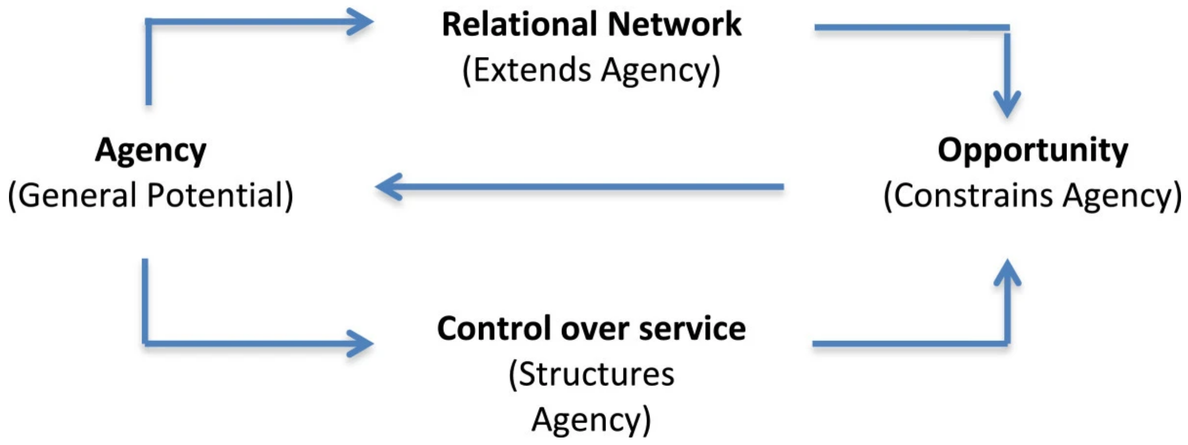


Figure 7-8: Mobilising capacity. From May et al. (2014)

7.3.1.1 Agency (general potential)

In considering the agency of individuals and their relational networks, the general health of such agents is a useful starting point. All had multiple conditions, some of which were life-limiting, including cancer, heart failure, and COPD. For some, these conditions limited the extent to which they could mobilise agency due to symptomatic exacerbations. For others, their general health and agency were hampered by side-effects from treatments themselves, such as in the case of Mel. On first arriving at Mel and her husband Scott's home, Mel produced a large shopping bag full of medicines, dosette boxes, and discharge prescriptions. A large number of these medicines were opioids or sedatives, and Mel found the effects of these often confounded her ability to engage with services and treatments:

> My memory has gone. My short-term memory's gone. Somebody can phone me and make an appointment on the phone. I can hang up the phone and [Scott] can say, who was that, and I'll go, oh, it was so-and-so. Oh, but what were they phoning for? I'll go I don't know, I think I have an appointment for something. What for? I don't know. When is it? I don't know. What time is it? I don't know. Where is it? I don't know. Well, do you know who called you to call them back and ask? No. [Mel]

Ruth was similarly on lots of medicines, including for her cancer, and had experienced several anaphylactic reactions requiring emergency resuscitation. However, both Ruth and her husband Tom still felt that they possessed reasonable agency for their age:

> I mean, let's face it, we're quite…reasonably fit and able to go about, and we've got the car. [Tom]

An individual's material situation (such as Ruth and Tom having access to a car) also affect the baseline agency of the individual, as do financial resources, adaptions to the home, and specialist equipment (such as hoists, bedrails, commodes). On a recent hospital admission, Nick (who has multiple complex needs and is cared for by his mum Stephanie) spent a large amount of time in his bed due to broken equipment, providing an example of how the removal of such material resources can reduce agency:

> …there was just the bit of frustration about the hoist, there being three hoists available that we couldn't use, because they…apparently, they weren't working or…I'm not sure…
>
> I mean, at home we can move and handle him okay with what we've got at home, hoist, you know, his bathroom, but we just can't the same in hospital, you know. [Stephanie]

There is also a psychosocial element to agency. Those who felt best able to cope with treatment burden displayed an equanimity when confronted with disruptions or potentially stressful situations. This was not uniformly shared by patient and carer dyads; often one party would feel more burdened by events and treatments than their counterpart:

> Bill: I mean, Irene is prone to being nervous about things, whereas I'm the absolute opposite.
>
> Irene: I can worry about not having a worry.

7.3.1.2 Relational network (extends agency)

The relational network (comprising carers, friends, relatives and healthcare contacts) provide a means through which agency can be expressed (May et al., 2014) and extended in order to undertake work. These networks comprise primary and secondary carers (discussed above), and also healthcare contacts.

Primary carers often served as a bi-directional intermediary between the patient and the healthcare system, for example by digesting and explaining clinical information to the patient, or by advocating for the patient and expressing concerns on their behalf. Andy's mother Patricia struggled with managing her medications and he had taken responsibility for organising her dosette boxes. He was fastidious about this task, having become frustrated after receiving the wrong medications in the past:

> …the number of times like the chemist round the corner has made a mess with prescriptions and all that and made a mess of it and I wouldn't let them be doing my mum's dosette box in case they missed out one tablet, which probably could be a very important tablet. So that way I know if I've made a mistake then it's my mistake – but obviously, I don't make that mistake. [Andy]

Andy was very active in Patricia's care and was further frustrated by not being able to get more involved when she was in hospital; not being able to advocate for her at the ward round was a particular issue. There was also occasional conflict between patients and carers, sometimes due to differing perspectives and prioritisation of tasks, and sometimes due to the impact caring had on the health of carers. Few carers were without health problems of their own, and the support offered was often reciprocal.

Support from the wider family, friends and neighbours was also valued. Some families lived nearby (proximal) and were always available (active), as Ruth explained following Tom's recent fall at home:

> Once I got him in bed, I thought, he needs the hospital. And I can't get him out of bed. Well, I just phoned and [Tom's son and daughter] were down there within half an hour. [Ruth]

Conversely, Barbara's family had all moved far from home and she received support predominantly from her friend and neighbour Theresa. However, when asked if she thought they would travel if she was unwell, Barbara's response was unequivocal:

> Yes! Oh, they would be on the first plane. [Barbara]

Coupled with the fact that her sons called daily and visited as frequently as work commitments allowed, they could be considered to be distal but active.

Friends and neighbours often played an active role as well. Irene usually took her husband Bill to the local hospital for his cancer treatment, but when asked if they had any further help they were able to name a list of people nearby who had either taken Bill before or explicitly offered to do so. A large part of the security felt by Barbara appeared to be because she stayed in such close proximity to similarly supportive friends.

Strong relational bonds with healthcare providers tended to be associated with long-lasting relationships or having a familiar, trusted person who patients and carers could get in contact with. Cancer care was frequently highlighted as a good example of this; Ruth had always felt she could access her named cancer nurse, and Bill's cancer consultant was seen as being very proactive, even finding him on the ward during an unplanned admission under a different specialty, to explain how his recent illness related to his cancer:

> She’s a bit like an elf, she pops up unexpectedly. I was in, [the hospital] …the first time, and she just appeared. She said, I was in the building, and I thought ’'d come and see you, and we’ll talk about this. [Bill]

7.3.1.3 Control over service (structures agency)

The way in which services are structured further determines the extent to which an individual and their relational network can mobilise agency. The disruption to normal practices caused by the need to conform to hospital regimens was a frequent issue. The problem of Nick spending long amounts of time in bed due to a lack of hoisting equipment is one such example.

Patricia drew comparisons between two wards she had been in recently. In the first she struggled to get her regular pain relief when needed and didn’t feel confidence in the staff. Both Patricia and Andy praised the second ward for attending to her pain relief promptly and ensuring her basic needs were met, despite staffing issues and the ward being busy:

> I told them that in the hospital, in [the second ward]. I said, I think I’m in a five-star hotel here. They were short staffed and they still made time to give me a cup of tea… they just couldn’t do enough for you. [Patricia]

Hospital discharge was also highlighted as disruptive, with Bill and Irene recounting a six-hour delay in receiving medications meaning that Bill had to wait on the ward. They proposed various solutions, such as going for a coffee and coming back or Irene going to collect the prescription, but felt frustrated that the hospital was unable to deviate from its normal practices:

> I was dressed… in anticipation that I was going to get picked up. Now, whoever should have been able to say to me, look, you go down to the atrium, have a cup of tea, that’ll let us get the bed and the room cleaned, ready for somebody else to be put into it. And a porter will find you, and give you your – if it is the porter – will give you your medication. I mean, that’s absolutely simple. [Bill]

The issue of getting to the hospital, both using patient transport and using NHS parking facilities was also problematic. Irene wanted to talk to someone about support for herself as a carer, and had wanted to do so when Bill was getting his cancer treatment (which she drove him to). However, despite both services being located on the same hospital campus, she struggled to drop Bill off and find a parking space. This resulted in a significant delay to her accessing these services. Patient transport (particularly in relation to getting home from hospital or attending routine appointments) was an issue for Patricia and Andy, with one occasion resulting in Patricia being carried (in significant pain) up several flights of stairs by her relatives, because they had an indeterminate wait on patient transport when discharged from the ED:

> …because my mum had to get a stairlift up the stairs that was taking 'til 11 o'clock at night, so my mum had been there from like one o'clock in the afternoon… so eventually I had to get a taxi and get my mum out a taxi and get my son to meet us at the stairs and get my mum's wheelchair and him and his girlfriend had to get my mum up the stairs, which was stressful for my mum. [Andy]

There were several examples where the organisation of care benefitted participants, particularly when it was minimally disruptive (such as allowing people to be cared for at home, or by automating burdensome tasks), or person centred (for example by tailoring medicines or providing respite to carers). Patricia had been cared for at home using a hospital-at-home service which was being piloted in the health board and was delighted to have avoided admission. However, the service was only available to people over a certain age. Nick's mother Stephanie was also a healthcare professional and felt that this service should be extended to people of all ages with complex needs. When asked if she thought some of Nick's recent admissions could have been avoided if he had been eligible for hospital-at-home, she agreed:

> I think so, because I mean, it's a brilliant service, and they really offer everything that can be provided that Nick would require in hospital, such as oxygen therapy… he's got a home nebuliser anyway that we need if…we can use if needed, but intravenous, they can provide intravenous antibiotics. [Stephanie]

Access to medication reviews was another positive element which allowed people to manage their burden more effectively, although access to such reviews was variable. Due to her allergic reactions to several treatments, Ruth had frequent reviews with a pharmacist which she found helpful. However, despite having a significant number of medications and feeling burdened by drowsiness and other side-effects, Mel described being told that she couldn't have a review because the doctor didn't want to 'upset the apple cart'. She thought that her GP was worried about being blamed for any negative consequences. When asked how she would feel if a change was made and she did become unwell as a result, she said:

> I wouldn't blame that on the GP. No, I wouldn't. I would just think, well, the GP has tried. We've tried to do without that tablet, obviously I can't do without it so I'll need to get re-prescribed it and that would be fine. [Mel]

The shift towards telephone consultations (a change which happened during the COVID-19 pandemic but had been retained by many services including primary care) was contentious. For some, it was convenient and less burdensome than having to travel for care, but others perceived it as limiting agency by preventing the patient from expressing themselves adequately. The main issue seemed to be around primary care; among those who complained about not being able to see a GP face-to-face, there were several instances where they were happy to interact with other services over the phone, such as specialist pain and cancer services. Ruth provided a recent example of when a practice nurse had detected non-verbal cues that she wasn't in good health, suggesting that these would have been missed had the consultation been over the telephone:

> I was in to get my blood pressure taken, usual, how are you, and I always say…you always say, fine, when you go in, whether you are or not. And she just looked at me and she went, you're not fine. Now a doctor can't tell that over the phone. [Ruth]

There were also several aspects of how services were structured which participants desired, mostly related to easier access to primary care and the ability for healthcare professionals (in various settings) to make decisions without the perceived bureaucracy currently preventing them. Bill used paramedics as an example of how he felt other healthcare personnel should be able to act, describing them as ‘action men and women’, people who had the capacity to make decisions which benefit the patient:

> …they’re action men and women. They are presented with a situation which they have to deal with, there and then. And they make decisions, there and then. There is nobody at their back, operating the blame culture, which is what happens, not just in the medical situation, but elsewhere. You know, to get somebody to make a decision is incredibly difficult, sometimes. [Bill]

7.3.1.4 Opportunity (constrains agency)

Opportunity is similarly concerned with the way services can affect agency but relates to the ways in which unequal distribution of services or eligibility can constrain the extent to which agents can act. In this analysis, the constraints can be described as either environmental, systemic or personnel mediators.

A commonly-discussed environmental mediator of agency related to the location of services and transport links to these services. One particular hospital received a large amount of criticism for being poorly-designed, however, several people commented on the fact that compared to other facilities in the health board it was extremely well-served by public transport and that this was a real benefit:

> …you can get a bus from [the other end of the city] right to the [hospital]. You see all the buses going in there. So there’s nothing like that for the rest of the hospitals. That’s the only good thing about [that hospital], no matter where you stay in Glasgow, there’s a bus route and it’s a direct bus to the hospital. And that’s good. [Tom]

The converse of this was when people or services were geographically distant or poorly served by transport links. Stephanie and Nick lived in a more remote part of the health board, and sometimes the carers who came to help with Nick couldn’t get there on time by public transport.

Personnel mediators relate to cases where the individual healthcare professional could constrain the extent to which agents could act. Examples include being talked down to, not being involved in goal-setting, perceived unprofessionalism, and (most frequently) poor communication. Most examples of poor communication related to experiences in hospital, for example receiving bad news and being left feeling unsupported in the aftermath. Mel had been left shaken by the seemingly abrupt delivery of a recent diagnosis, and although she received a better explanation the following day she had resorted in the interim to searching online for information:

> He just came in and he went, yes, Mel, yes, you've got stage four heart failure and I went, well, what does that mean? He went, oh well, that's the last stage that you can get. Your heart's failing. So I Googled it and it says within six months to a year, you know, you're dying. I'm thinking, eh, what's going on here, you know what I mean? That, kind of, did freak me out, didn't it? [Mel]

Systemic mediators relate to structural aspects of the healthcare system which constrain agency. Communication was again discussed, in relation to information sharing and organisation between healthcare services. Ruth and Tom documented two examples of this in their journal, when a breakdown in communication between the GP and pharmacy required Ruth and Tom to make multiple phone calls and trips to the GP and pharmacy in order to resolve:

> Phoned doctor and said co-codamol pills were not helping my knee. Doctor said she would give me stronger co-codamol. Collected prescription from chemist and when I returned home they were the same ones I had. Phoned doctor and explained. She said she would give me new prescription. Called at health centre for prescription and was told it was at [pharmacy]. The pharmacy did not have it. By now the surgery was closed for the weekend. Finally got pills after much harassment. Luckily we have a car as I could not walk for the pain. [Tom & Ruth's journal]

Other examples of systemic mediators include short staffing (particularly in hospitals), gatekeepers (particularly GP reception triage), and reduced access to respite care.

7.3.2 Expressing capacity

The next dimension to be explored relates to the way capacity to undertake work is expressed. The ability to secure cooperation from others through whom informational and material resources flow extends functional performance. In turn, the structural resilience of these networks and their ability to cope with adversity feeds back to the functional performance of the patient and their relational network (Figure 7-9).

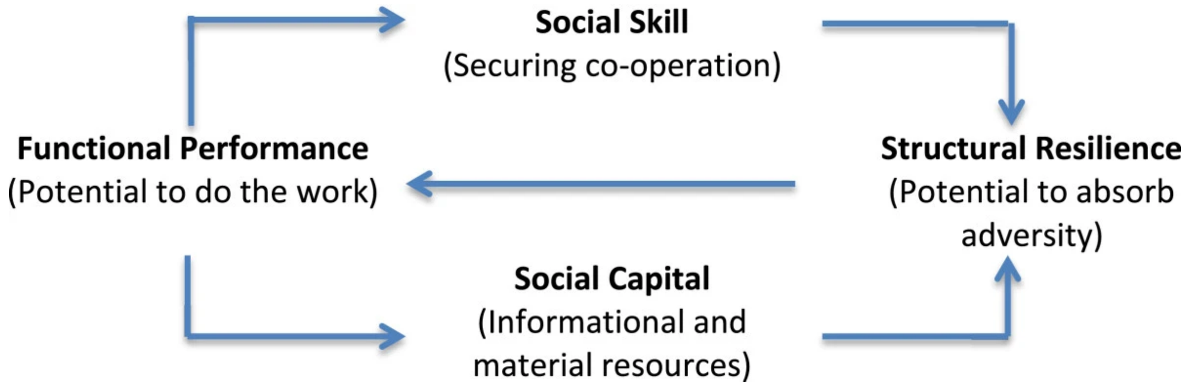


Figure 7-9: Expressing capacity. From May et al. (2014)

7.3.2.1 Functional performance (potential to do the work)

Functional performance relates to the degree to which patients and carers possess the cognitive and material capacity to undertake the work of patient-hood (May et al., 2014). As noted earlier, Mel's agency was limited by side effects from her medications. In the same way, her functional performance to organise her medications diminished due to these effects, which meant that Scott had to take over. However, when Mel reduced the sedative effects of these medications, her functional performance increased and she was able to undertake the work herself:

> [Scott] used to do all my medicines for me but since I've come off quite a lot of my painkillers and that and my head's clearing, you know, I've been under all that drug fog and all that…yes, I'm able to do it myself [Mel]

Fluctuating functional performance as a result of medications, side effects and interventions was common. Both Barbara and her friend Theresa had undergone injections to the eye as treatment for macular degeneration in the past. While they were both fairly independent, the recovery period from these treatments involved rest and spending time in a dark room. In preparation for this period of diminished functionality, they would have to make sure they had shopping in, and had someone to take them to and from the hospital. Fortunately, both were able to utilise their social skill and leverage social capacity in order to absorb this adversity.

7.3.2.2 Social skill (securing cooperation)

Social skill relates to the way patients and their relational networks can engage with others and secure cooperation in order to undertake work (May et al., 2014). Maintaining good relationships with healthcare providers tended to be the most common example of this. Stephanie and Nick had been with the same GP practice for most of Nick's life, and Stephanie reported that despite most appointments being done over the phone, she had no trouble having Nick seen promptly when needed:

> …the practice know Nick and they know he's very vulnerable and can become ill very quickly, they would…you know, if I felt he needed a face to face, then they would offer him one that day [Stephanie]

Exercising social skill usually involved leveraging existing relationships with named individuals, with GPs and cancer services being the most frequent examples of this. Bill had a chest infection on top of his COPD and had become used to receiving a longer course of antibiotics, however when he saw a different GP they wouldn't prescribe this and insisted he try the short course. When this failed to resolve his infection, Bill used his existing relationship with another GP in the practice to get the usual course of treatment which successfully cleared the infection. Bill characterised this relationship as one in which he felt like he could question and challenge things, and receive a satisfactory response:

> To be honest, she's the only one I really…trust is maybe too strong a word. But she has a different perspective [Bill]

Particularly amongst older participants, there appeared to be a conscious effort to navigate the system either by utilising these relationships, presenting themselves well (to avoid being seen as frail and vulnerable), or expressing insider status (where this was an option). For example, before he retired Tom had a non-clinical role in the NHS, and when attending the ED or outpatient appointments he would let slip a comment to demonstrate he understood the equipment being used or the way the department worked. Ruth and Tom also mentioned a friend who used to dress well for the hospital to make sure she was taken seriously:

> Tom: She always dresses up before she goes. She always dresses up smart…
>
> Ruth: Uh-huh. I've got a friend that always gets all her makeup on and gets all dressed up and goes because…'cause of her age, because she says, they think you're old and decrepit and they don't bother.

Participants were prevented from creating useful relationships with healthcare providers when care was discontinuous and fragmented, or when prior experiences had fostered a mistrust of health services. Feeling let down by the care his mother had received, Andy had become suspicious that there was an element of ageism driving decisions, and this suspicion seemed to have extended out to most services. He spent time researching treatments and investigations for Patricia, but felt that these were largely ignored when he suggested them to clinicians:

> I feel as if it's kind of ageism, you know what I mean. You're a certain age, well you're kind of…people living to 100, they don't want people living to 100, because it's too much for the health service [Andy]

7.3.2.3 Social capital (informational and material resources)

Functional performance is extended through social skill and ability to secure cooperation, and it is through these relational networks that informational and material resources which help to undertake work are secured (May et al., 2014). Information about conditions, procedures and how to secure further cooperation can increase functional performance, but also provide reassurance about potential fluctuations in capacity. For example, Barbara had a good relationship with the carers who helped her with her morning routine, and when asked how she would go about getting more support if she needed it, she had a number of different options which she felt comfortable using:

> I would probably start by asking the carer that was already in how to do it, and if not, 've got some telephone numbers up there, we would phone the council up or… I might even phone the doctor. [Barbara]

Conversely, when information doesn't flow through social networks it can result in reduced capacity to perform work. An example of this would be Irene, who despite finding it difficult coping with Bill's cancer diagnosis and adapting to her own role as a carer, didn’t access support for this till a year after Bill’s diagnosis:

> I found that quite difficult. I haven’t really been given any information on caring, or accessing [support for carers]. In fact, I didn’t even know where the [carer’s support service] was. [Irene]

Access to material resources also extends functional performance. Irene and Bill reflected on the fact that they were financially comfortable enough to do things like pay a cleaner to help with housework or pay for travelling to the hospital and parking when they had to, but that for many others this would not be an option. However, capacity to expend material resources was also related to the extent to which individuals had limited alternatives. Andy was a full-time carer for his mother Patricia and had been unfit to work for a long time due to his own poor health. Frustrated by waiting on specialist care, he had spent large amounts of his own money on private consultations. He wasn’t ambivalent about these expenses, but feeling that he wouldn’t be seen any other way he deemed them a necessity:

> I had to pay £250 just to see a neurologist. But do you know what, it was worth every penny… So that’s me diagnosed within 20 minutes, so he diagnosed…which gave me peace of mind ’cause you’re thinking all sorts of things, you know what I mean? [Andy]

Other material resources which extend capacity include adaptions to the home, specialist equipment (such as hoists), and call-alarms. During the study period, Andy and Patricia were in the process of having adaptions made to the upper level of Patricia’s home so that she could shower and use the bathroom safely, and Andy had been coordinating this on behalf of Patricia. She had also received a call alarm and was having bed rails fitted. Patricia had recently fallen out of bed and fractured her arm, and her functional ability to undertake daily activities and the work of patienthood had diminished, necessitating these changes.

7.3.2.4 Structural resilience (potential to absorb adversity)

Structural resilience relates to the ability of patients and their relational networks to absorb and respond to adverse events such as biographical disruptions, acute illness or social changes (May et al., 2014). In this study, structural resilience has been explored at three levels: individual resilience, relational resilience, and material resilience.

Individual resilience in this context relates to the psychological capacity of the individual to absorb adversity. This was most commonly demonstrated through participants reacting with equanimity to stressors during the course of the study, or by projecting a relaxed attitude to future work. For some this equanimity was developed over time through repeat exposure to the stressor, such as in the case of Ruth’s allergic reactions. When asked if being taken to the resuscitation room and receiving treatment was a frightening experience, she replied:

> Well the first time, but after that we got used to…we knew it was…well we know …what was causing it. [Ruth]

For others, their individual resilience seemed to be more established, framed as a deeply ingrained trait rather than a newly adapted coping mechanism. Barbara had several recent emergency admissions to hospital, including during the study. She had spent several hours in the ED before being admitted to a ward, had fasted till the evening on three consecutive days for a procedure which was repeatedly cancelled, yet brushed these events off as mere inconveniences. When pushed to say whether she felt inconvenienced by the repeated cancellations, she dismissed the idea:

> Listen, if that’s all we suffer, it’s not a great deal to be honest, if you watch that television. [Barbara]

Resilience can also be explored at the level or carers and members of the relational network. The majority of carers had their own health problems, which meant that caring took a physical and mental toll on them. Several patients stated that they felt like the carer suffered more than they did, often due to stress as a result of the patient becoming ill or receiving bad news. Mel had spent a significant amount of time in hospital in the months leading up to the study, and each time she worried about how Scott was coping:

> Scott seems to come out the worst off whenever I have an illness or I get not well or a new diagnosis or I get admitted to hospital. He seems to get really, really not well with stress. He can’t handle the stress of it. [Mel]

Moving beyond the patient/carer dyads, the resilience of wider relational networks was also explored. For some older participants, they had seen friends and relatives who had previously been part of their support network die in recent years, which affected their ability to cope with adverse events. Barbara and Theresa reflected on this:

> Theresa: I mean, there are loads of people in my case and I would have phoned but…they died.
>
> Barbara: They are dead.
>
> Theresa: They died early on, they were younger and they died, you know. You are the same.
>
> Barbara: Yes.
>
> Theresa: And, some of them are older of course and they have died. I mean, I couldn't believe when we moved in here how many people had died that I really depended on and was a great support…

The wider, secondary relational networks played a significant role in how people perceived their resilience. The extended family, friends and neighbours were seen as resources which could be called upon to provide support should they be required.

Material resources were important sources of resilience, but also served as a reminder of how precarious such resilience could be. A particularly illustrative example was car ownership. Many participants reflected on how they relied heavily on their car to get to and from appointments or to get to the hospital in an emergency, and having access to a car provided reassurance that should an adverse event occur, they would be able to access help. However, if the car was to break down it would significantly constrain their functional performance. Mel and Scott had been in a minor collision the day before the first interview, and they spent a period of time calling insurers and trying to ensure they were allowed to drive, noting that they would struggle to cope without it. Similarly, after Tom's fall he was unable to drive for a period, which meant Ruth had to take over much of this work.

7.3.3 Mobilising for delegated tasks

The preceding domains of the theory relate to capacity; from this point on the focus is on the undertaking of the work itself. For work to be undertaken and normalised, it must be first be conceptualised before being enacted. Parallel to this is a need to build and maintain the relational networks which extend both agency and capacity. Finally, the work must be appraised, a process which feeds back into the conceptualisation of the work to be undertaken (Figure 7-10).

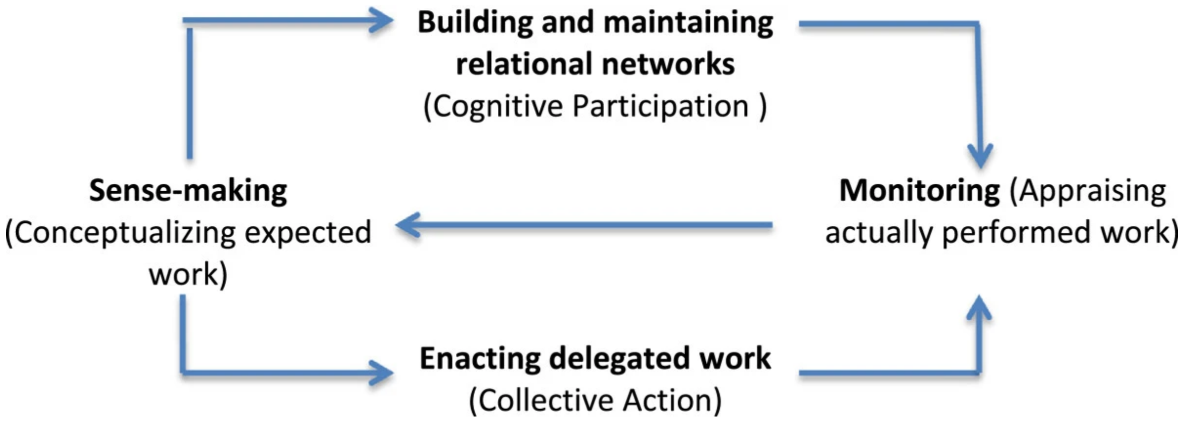


Figure 7-10: Mobilising for delegated tasks

Enacting delegated work is a key part of the mobilisation process; however, Burden of Treatment Theory explores this through a more granular model related specifically to enacting delegated tasks. This will be discussed in a later section (7.3.4 Enacting delegated tasks, page 197).

7.3.3.1 Sense-making (conceptualising expected work)

For patients and their relational networks to undertake tasks, they must be able to conceptualise individual tasks alongside the myriad components which make up their workload. Some patients were able to understand and execute novel tasks effectively after receiving instruction from healthcare professionals. For example, when Tom had to start self-administering a drug by injection he was able to explain what condition it was for, how it should be taken, how to store it and what effects it should have. Most participants were able to conceptualise why they took medicines, although for some this required their carer to explain things to them, such as in the case of Patricia and Andy:

Andy: Sometimes my Ma might pick up something the wrong way, and then, I'll say, no, they meant it a different way, and she'll be like that, oh right.

Patricia: In the hospital when they're giving me my tablets, they put them in a wee cup thing. I'd ask him [Andy], what's that, what's that, I want to know what they're giving me.

Non-pharmacological interventions and self-care activities were sometimes less well conceptualised, particularly when patients and carers were presented with conflicting information. Bill had been exercising and monitoring his weight in order to reduce the breathlessness he experienced due to his COPD but had also been told that it was important not to lose too much weight while undergoing his cancer treatment. While Bill conceptualised his daily walk and other exercises as being important, Irene was worried about striking the balance between what they understood to be best for Bill's cancer and his COPD:

> Although the only thing that worries me slightly is the oncologist said she really didn't want him to lose too much weight. I think she wants him to have a backup… So, it was trying to strike the balance between that… He hasn't felt as hungry this last couple of weeks, since the radiology. You haven't felt as hungry. Although you had the chest infection, and you weren't out as much. So, now that you've got rid of the chest infection and you're out in the garden a bit more, that might stimulate your appetite. [Irene]

The other potential is for tasks to be simply misunderstood and therefore not engaged with. It became clear while Andy and Patricia were discussing topical analgesic patches that the reason why Patricia had stopped using them is that she hadn't fully conceptualised how the patches worked, despite Andy trying to clarify:

Andy: See like when you've got the patch on, obviously when you take the patch off, you're going to feel pain.

Patricia: Why?

Andy: 'Cause the patch is not on.

Patricia: Well that's what the patches go on for.

Andy: 'Cause you keep it on for 12 hours.

> Patricia: I keep it on for 12 hours, I take it off and the pain comes back. Am I doing the right thing? I don't know.

7.3.3.2 Building and maintaining relational networks (cognitive participation)

Cognitive participation relates to the work of maintaining relational networks and building them in anticipation of expected work. Most primary carers were cohabitant with the patient, the exception being Barbara and Theresa who stayed in the same building. Their relationship involved a more proactive approach to maintenance, checking-in with one another several times daily despite having busy schedules:

> We just, sort of, keep in touch. Like in the mornings, we phone each other once or twice. You know, Barbara will phone me or I'll phone her and say, how are you this morning, kind of thing. And see what we're doing through the day. We each have plenty on as it were. [Theresa]

Maintaining wider social networks for many simply involved staying in touch with friends, family and neighbours and keeping them up-to-date with developments. Tom, who as mentioned previously worked in a hospital, made a more proactive effort to keep in touch with ex-colleagues, which proved useful when he and Ruth had to attend an unfamiliar hospital for an outpatient appointment:

> [My ex-colleague] was working down there, so we just phoned her. She works… so she got a promotion, so she was down there. So we just phoned her, what's the best way to get there, and what have you. Oh right, I'll meet you for lunch then… [Tom]

7.3.3.3 Monitoring (appraising actually performed work)

The process of reflexively monitoring performed work contributes to the conceptualisation of work, in the sense that work which is perceived to be effective will be understood as worthwhile and thus increase the likelihood of it being normalised. Self-directed physiological monitoring of blood pressure was a common example of this. Given that overprescribed antihypertensive medication can lead to side-effects, most participants appraised the efficacy of their medications through the use of automatic sphygmomanometers and symptom surveillance.

Pain was another metric through which the effectiveness of performed work was measured. Several participants were on combinations of analgesic medications, and engaged with their GP or pain clinic in order to achieve optimal balance between relief and side-effects:

> So, see because I've taken tramadol for years and I felt as if I was taking it for that many years they just weren't having any effect, so I just told them just to stop them because I didn't see the point in taking something that wasn't effective. [Andy]

Finally, for some carers it was important to emphasise that they didn't perceive the burden of treatment as work, as their act of caring was an expression of closeness with their loved one:

> The other day my husband, Nick's dad said he never heard me complain about caring for Nick. I replied "it's because I really love him". (He never complains either) [Stephanie & Nick's journal]

While the efficacy of specific tasks may be monitored and appraised, the perceived importance of the overall act of caring is also reinforced by the strength of such relationships.

7.3.4 Enacting delegated tasks

The final domain of the theory which will be discussed in this section relates to the undertaking of patient work at the more granular level of individual tasks. In the first section the types of work undertaken are outlined using a thematic framework. The ability to undertake these tasks and for them to become normalised is dependant on the patient and their relational network possessing the necessary skill-set and having access to locally-exploitable resources. Finally, the normalisation of such work depends upon the perceived confidence in the outcomes achieved, which in turn feeds back into the work which is undertaken (Figure 7-11).

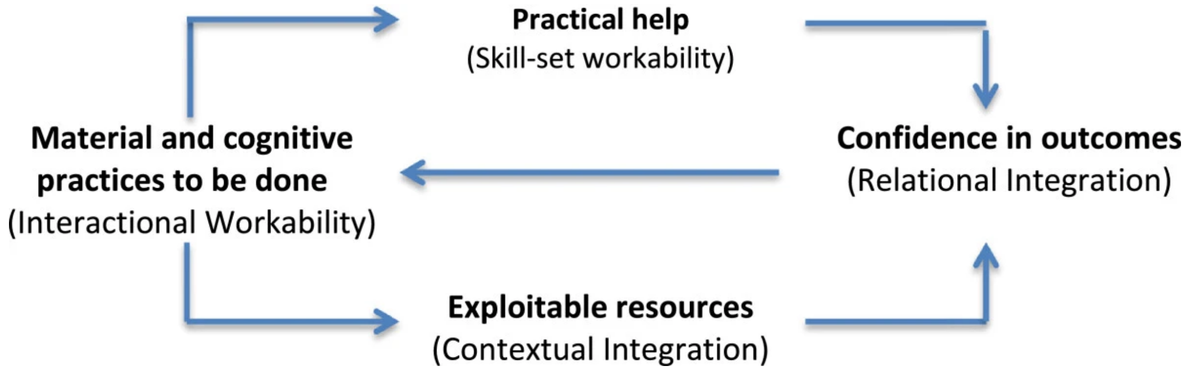


Figure 7-11: Enacting delegated tasks

7.3.4.1 Material and cognitive practices to be done (interactional workability)

The material and cognitive practices undertaken by patients and their relational networks comprise the actual enacted work of patienthood. In this study, these are organised under five themes: Accessing care, diet and exercise, medication and interventions, organisation, and surveillance (Table 7-1).

Theme	Subthemes
Accessing care	Hospitalisation Outpatient appointments Primary care Travel and transport
Diet and exercise	Maintaining a healthy diet Physical exercise
Medications and interventions	Organising medications Taking medications Basic care
Organisation	Doing administrative tasks Planning ahead Waiting for care
Surveillance	Monitoring medications Symptom surveillance Self-initiated treatment

Table 7-1: Thematic framework of enacted work

Accessing care

A common theme was the barriers patients and their relational networks faced when accessing services, both in terms of the processes involved and the physical act of travelling to locations where care was delivered. Given that participants were recruited from the ED, attending the hospital and hospitalisation was discussed often. The disruptive effects of a hospital visit were felt keenly by most participants, and included delays or discontinuity in routine medications, poor access to specialist equipment (such as hoists), and poor communication between clinical teams and carers. Mel, who had spent a very large amount of time in hospital recently, had been trying to take control of her own medication administration while admitted:

> Oh, well, give us your dosette box. No, you're not getting my dosette box because every time you take my dosette box, I don't get the right meds, do you know what I mean. So, when I go in now, I say, no, I'm taking my dosette box. I'll do my own meds. [Mel]

There were also worries about hospitals as a source of iatrogenic harm, through repeated failed attempts at cannulation or the acquisition of hospital acquired infections. The majority described hospital care as a negative experience to varying degrees, but some participants did have praise for the overall system, despite being aware of the ways in which things could have gone wrong:

> The most important thing, is the speed at which the system has worked to my benefit. Which only has been…and actually hasn't been hampered, to any appreciable extent, but it could have been by the inefficiencies systemic in the system. [Bill]

Bill's comments above relate to his experience both as an inpatient and while accessing outpatient care. Perhaps unexpectedly, despite the multiple chronic conditions represented by the participants, none had any significant burden of outpatient appointments to attend, and most only regularly saw one specialist team, if any. Post-pandemic, most outpatient appointments had moved to being telephone-based - excluding when physical assessment was necessary.

Telephone consultations and triage were also a common feature of discussions relating to primary care. As mentioned earlier, some participants appreciated the convenience of speaking to their GP over the phone, but others felt it was an inadequate replacement for face-to-face contact. There was also conflicting information about accessing face-to-face appointments, with some reporting seeing a GP on the day and others stating that the practice simply wouldn't see them. The attitude to being triaged by reception staff was mostly negative, and for several people it had developed into enmity, in turn resulting in complaints, moving practice, and even litigation.

Where primary care was viewed most positively was when it represented continuity, either through patients being registered at the same practice for a long time, or through seeing the same doctor or nurse. Ruth was unhappy that she didn't have continuity with the GPs she saw, but was very positive about the nurse practitioners at the surgery who she attended regularly:

> I think they get to know their patients and get to know…I think it is quite a good…I mean, years ago…when I was younger, you…I mean, you knew your doctor. Your doctor knew you. Not now. Not the same now. [Ruth]

There was also a desire for more holistic patient assessment, and being limited to only discussing one problem at a time during GP visits was a source of complaint:

> …if you go to see a doctor, right, 'Mel, what can I do for you today?' She'll start to tell him. 'Oh, I can only deal with one thing'. Well, she's very complex, you know, so she'll be saying, well, 'my legs are swollen and I've got these little spots, stuff like that', 'but I can only deal with one thing'. [Scott]

Finally, the issue of getting to and from healthcare settings was a major problem. As mentioned earlier, issues around parking at hospital sites or waiting on ambulance transport were the main focus for some participants, but dealing with traffic and navigating public transport were also discussed. Tom used to drive Ruth to her oncologist appointments, but the location of these would often change and involve them having to drive 20 miles through rush hour traffic to the hospital. They lived within walking distance of a large hospital well-served by public transport links, but would often be directed to various others across the health board. Occasionally they would manage to change these, but not always:

> So I just wait ‘til the appointment comes in on the letter and I phone up and I just say, doesn’t suit, can you make me an appointment for [the local hospital] and you get it no bother. You know, I mean, you should see the hill at that other one. And the thing is, even if you go in the car, you get…you never get up the top. You're always at the bottom of the hill. By the time you get up, you're not worth a button. [Ruth]

Diet and exercise

Maintaining a healthy diet and exercising was usually self-initiated by patients and carers, rather than being prescribed by clinicians. For example, those who had type 2 diabetes didn’t share any guidance they had been given alongside their medication. Dietary changes would best be described as sustainable and small modifications rather than adhering to any specific plan:

> I’ve grown up with a Mediterranean diet. We’ve always used olive oil and a lot of vegetables. Our problem, from my background, is the portion size. We tend to eat too much. So, we have both trimmed that down a bit. And we’re trying to not have as much at lunchtime. Whether that’s good, bad, or indifferent, we prefer having a meal at night; we eat about half-six. [Irene]

Exercise similarly tended towards small and sustainable ways to keep active rather than any structured regime. Some participants had been prescribed physiotherapy after an injury, but none fully adhered to the planned exercises for the prescribed duration of treatment, preferring to use their injured limbs as functionally as possible in the hope that it would aid healing. As discussed earlier, Bill had been trying to achieve and maintain a healthy weight to help with his breathlessness; he had previously played golf and swam but had recently been unable to do so. His regime now consisted of ten circuits of a quiet cul-de-sac near his home daily and tending his garden, both of which he felt were valuable activities:

> I could walk for hours and hours and hours when I was younger. But now, losing some weight and doing that…practising out the back there, does definitely benefit me, I feel. It helps my breathing, and it helps the mobility in my joints and my legs. And I feel better for it. [Bill]

Medications and interventions

The overall theme of organising care will be discussed in the next section, but the organisational demands of medications merit separate discussion. Dosette boxes, medication deliveries and automated processes for ordering medicines were all seen as useful ways of reducing the burden associated with organising medications. However, when changes had to be made or deliveries rearranged, some found that it was difficult to communicate with services. When Barbara was admitted to hospital, Theresa spent a very long time trying to let the pharmacy and GP know that Barbara wouldn't be home to receive her medication delivery, and was frustrated by the lack of communication between services:

> They don't seem to be able to do the thing that everyone else seems to do with cars and insurance and whatever, they know right away whether you have been insured or whether you've got your licence and all this kind of thing, that doesn't happen in medicine yet. [Theresa]

The main issue around taking medications related to side effects, either from individual medications or from polypharmacy. Some participants had suffered reactions which necessitated emergency care, and others had been admitted to critical care. Feeling over-sedated was also a feature, with some patients experiencing injuries which they believed were precipitated by taking too many sedative medicines. Being unprepared for side-effects compounded problems; Irene had started a course of medications and wasn't aware that they could cause a temporary low mood and was considering stopping treatment because of this. She had also noticed Bill's behaviour change when he was taking steroids, and had to contact the cancer service for guidance:

> I thought, on the steroids, he was quite aggressive, and a bit hostile. And you're not as, you're not like that, now, you're calmer, now. And I found that…I found that quite difficult. [Irene]

Medications were not the only clinical and caring interventions undertaken by patients and carers in their own homes; others included stoma care, self-catheterisation, enteral feeding, tracheostomy care, and assistance with activities of daily living. Stephanie noted in her journal how she felt overwhelmed on one occasion when Nick was acutely unwell, spending a large amount of the night awake cleaning blood, vomit and other bodily fluids from soiled bedclothes while trying to observe Nick and keep him comfortable. As noted earlier, when these interventions are being undertaken by a carer for their loved one it can be uncomfortable for the carer to class them as 'work'. Despite being normalised in this way into the daily routine, these acts do still comprise important elements of treatment burden.

Organisation

Alongside the medications, interventions, interactions with services and the activities people do to stay healthy, there is the day-to-day administrative and organisational tasks required to ensure the work of patienthood can be done. This often takes the shape of telephone calls, keeping diaries, planning journeys and arranging work or social commitments around caring responsibilities. For Stephanie, who still worked part-time and had to arrange social care for Nick, there was also the added work of keeping accurate financial records:

> I think once a year or every 18 months, the social work department, they ask us…we do…we could get direct payments. I mean, we then pay the bills, you know, the services ourselves, so we get kind of a lump sum every quarter, every three months.
>
> And then we have to, every year, every 18 months, we have to justify where that money's gone to and show bills that we've paid and also bank…a bank statement, to show where the money's gone to and what it's been used for as well. [Stephanie]

The organisational aspect of patient work places cognitive demands on the patient and carer, requiring them to plan ahead. These can range from minorly disruptive, such as having to pre-dispense medication or ensure commodes and other equipment are in the right place when needed, to significantly disruptive events such as having to reschedule holidays or plan for recovery time around other work and social commitments.

Much of this organisational work takes place in the context of indeterminate waiting, increasing the cognitive burden placed on patients and their relational network. Waiting on outpatient appointments, surgical procedures, or adaptions to the patient's home are long-term burdens spanning days, weeks and months. However, there are also the shorter waiting periods which require the patient and carer to be organised and prepared to act. Examples of this include waiting on transport to return home from hospital, waiting on discharge medications, waiting on test results, or waiting on inpatient medications (such as pain relief). There was a real disparity between how individuals responded to similar demands, ranging from anger and disengagement, to acceptance and equanimity. Andy, who suffered from comorbid pain conditions had on several occasions discharged himself from services and paid to go private, frustrated by the wait. Barbara, on the other hand was markedly unmoved after having a surgical procedure delayed by several days:

> It was just part of life…one needs it more than you and you will wait. So, I didn't complain about that, and everything else was fine. The staff were adorable. [Barbara]

Surveillance

Similar to the act of organising care, performing surveillance of medications and symptoms and being prepared to act in response to changes places a cognitive burden on patients and carers. Medication and symptom surveillance can be undertaken independently of one another, but most commonly comprise a feedback loop whereby either dosage is titrated to alleviate symptoms, or symptoms are monitored for their association with certain medications and the medication is stopped accordingly. The reality of this process rarely resulted in either the complete resolution of symptoms or by finding a definitive cause of side-effects. Ruth’s frequent issues with polypharmacy have been discussed; as illustrated in this quote she was engaged in frequent monitoring of the effects of medication and adjusted her treatment accordingly, in this case after developing a cough while taking Bendroflumethiazide:

> I was getting a cough all the time. I bought three different cough bottles and it was still here and I went…and then they upped the dose on it ‘cause my blood pressure was still high. They upped the dose on [the Bendroflumethiazide] and I coughed even worse and then I realised…I went, that’s that pill, and I read the effects. So I stopped that on Friday. [Ruth]

Symptom surveillance could be described as either active or passive. Active surveillance involved checking for signs (such as blood pressure or oxygen saturation) which indicate a need for treatment to be altered. Passive surveillance involved maintaining an awareness of the reason for certain treatments and engaging with them when symptoms were present, such as pain, discomfort or nausea:

> That’s the extra pills…one of the extra pills that I haven't counted in with you. And sometimes when I’ve got a big flareup I can take eight a day or maybe six. It’s a…I do take…very important and they get me feeling better. [Barbara]

In some cases, surveillance led participants to consult with healthcare professionals, but (as described above) often the decision would be made by the patient or carer to initiate treatment. Mostly this involved taking medicines or treatments prescribed for ‘as-required’ use, or over-the-counter treatments. However, limited access to services can also drive patients to undertake work which is more risky if they identify a need for treatment, such as in the case of Mel detoxing from intravenous drugs after being unable to access addiction services as promptly as she desired:

> I asked my drugs worker to do it and she said, oh, do it over six months or a year because we don’t want to do it too quickly, too fast or anything like that. You’re on a lot of other medications and you’ve got a lot of illnesses so we need to do it very, very gently and slow. So I decided, well, I wasn’t going to wait six months or a year, I would do what I knew you got in a detox centre which was a nine-day detox. So I did it myself, a nine day detox, and I came off it. [Mel]

7.3.4.2 Practical help (skill-set workability)

The successful embedding of delegated tasks into everyday practice depends on patients and their relational networks possessing the necessary practical skills (May et al., 2014). This can be exemplified in the work described in preceding sections. Firstly, we can take the example of Stephanie and Nick. Nick requires significant care including enteral feeding and medicine administration, and using a home nebuliser. Stephanie is a healthcare professional, and while anyone who is caring for a loved one with complex needs such as Nick’s would receive training, it is a reasonable assumption that Stephanie’s professional skill-set would have provided a strong foundation on which to learn the intricacies of performing these daily acts of care.

> Nick became suddenly wheezy and breathless. Nebulised with salbutamol and saline. Nick dislikes the mask and I had difficulty holding the mask on his face. Eventually however, Nick improved after a bout of coughing. Felt very anxious for Nick at the time though, I thought we may be heading for hospital. [Stephanie's journal]

Conversely, Patricia deciding not to use her topical anaesthetic patches because she hadn't fully understood how long they lasted is an example of where a practice fails to be normalised due to the absence of the necessary skill-set to appraise how effective the treatment was.

7.3.4.3 Exploitable resources (contextual integration)

Normalisation of tasks is similarly dependent on access to local resources, such as the informational and material resources discussed earlier. A useful example of this is provided in the differing approaches to physiotherapy employed by Barbara and Patricia. Both women had been advised to do exercises and physiotherapy following an injury. However, when faced with long waiting times for this treatment, Barbara was in a position to make use of financial and informational resources to see a private physiotherapist promptly, while Patricia experienced a longer delay. As such, Barbara was able to normalise the practice of doing her daily exercises by incorporating it into her routine:

> Barbara: Well my…yes, I've to do these exercises.
>
> Chris: So is that, sort of, physiotherapy after you've had your [injury]?
>
> Barbara: Yes. Physiotherapy. Yes. And I've to do…I do these…I do them sitting watching television. It's so easy…

7.3.4.4 Confidence in outcomes (relational integration)

The normalisation of tasks and whether they are likely to be adopted in routine practice also depends upon the degree to which patients and their relational networks possess confidence in the tasks and their outcomes. Continuing with the example of Barbara and Patricia, both women eventually dispensed with physiotherapy when they decided that the exercises no longer produced a perceptible difference in their functional ability to use their injured arms. The difference, however, is that Barbara (due to her access to exploitable resources and having acquired the necessary skill-set from seeing a physiotherapist) completed a course of treatment, whereas Patricia had discarded her sling and tried simply to carry on as normal without rehabilitation:

> Patricia: The lassie came out yesterday.
>
> Chris: And how's the physio going?
>
> Patricia: Well, actually, she said to me, how are you getting on with your physio, and I said, I never done it. I was just using my arms as if, as if... As if there was nothing wrong. And then she started laughing, and she said, she's just given me a few things to do, and I said, do I really need to, because she doesn't really need to come out, I can do them myself, you know.

7.4 Improving care for people with multimorbidity and their carers: uncertainty and treatment burden

Burden of Treatment Theory provides a framework through which the capacity of patients and relational networks to undertake work is balanced against the workload placed on them. In this final stage of the analysis, the argument is advanced that a second, overarching theme is present which intersects with Burden of Treatment Theory at various points, and that this theme plays a central role in both eroding capacity and increasing workload. The theme with which this section is concerned, is *uncertainty*.

Uncertainty in the context of multimorbidity is multidimensional and dynamic. A model of total uncertainty has been proposed by Etkind et al. (2022), in which physical uncertainty (i.e. appraising multiple conditions), practical uncertainty (i.e. fragmented care), social uncertainty (about others, such as healthcare professionals), and psychological/existential uncertainty (i.e. feeling overwhelmed) exist in a state of continual change. Furthermore, Hillen et al. (2017) propose a conceptual model of uncertainty tolerance, in which the cognitive, emotional and behavioural response to an uncertainty trigger (i.e. ignorance resulting from probability, ambiguity or complexity) is moderated by characteristics related to the trigger, the individual, their situation, as well as cultural and social factors. The argument to be advanced in this section is that the generative mechanisms of Burden of Treatment Theory can be used to understand how people cope with uncertainty, and that the total uncertainty experienced by people with multimorbidity can destabilise the balance between workload and capacity which comprise treatment burden. Therefore, in order to ensure care is manageable there is a need to acknowledge and address uncertainty.

7.4.1 The point of inflection: uncovering uncertainty

Uncovering the concept of uncertainty resulted in part from the analysis of reflexive journal entries, and a process of retroductive reasoning. From a critical realist perspective, Burden of Treatment Theory is an intransitive theory which holds great explanatory power in understanding how capacity and workload transact in this patient group, but the meta-theoretical position allows for the intersection of other intransitive theories. For several patients and carers, there appeared to be an unseen factor destabilising the balance between workload and capacity. The following diary entry outlines one such observation. Irene had finally managed to access carer support services, and was relieved to have done so after feeling unable to for so long. Lots of things had contributed to this decision deferral: being unsure if she could just drop in to the centre, worrying about getting a parking space, being unsure if she would get back in time to pick up Bill, worrying about finding the centre, and many others. The sum of these accumulated small uncertainties was sufficient to prevent Irene from accessing services, but all it took to overcome them was to be reassured by the staff at the centre. The decision was made to pursue this line of enquiry further:

> I brought this up; how the barriers to access can be so low but still forbidding. It's almost as if we sometimes need to be given permission to use services, even when we have previously been directed to services and told to access them if we need them. We talk about 'signposting' a lot and how this is important, but sometimes it isn't enough to just point at a sign and send someone on their way; sometimes we need to take someone by the hand and escort them, invite them in and let them know that they are supposed to be there, that this place is *for* them. [excerpt from Chris' reflexive diary]

This exemplified that the problem wasn't simply one of informational flow; Irene already had all the information about the centre. What was missing was the 'permission' provided by the staff at the centre. This permission provides a sense of certainty, it alleviates what Hillen et al. (2017) describe as the negative psychological response to a conscious awareness of ignorance, in this case about whether to access a support service for carers.

This is just one of several examples which led to the exploration of uncertainty as an affective factor in the balance between capacity and workload. In the remainder of this chapter, this relationship is described in five themes. The first explains the ways in which *uncertainty erodes capacity*, while the second explores how *uncertainty increases workload*. The third theme exemplifies how some people are *coping with uncertainty*; conversely the fourth theme shows cases where people are *struggling with uncertainty*. The fifth and final theme is concerned with the ways in which healthcare providers can offer *guidance through uncertainty* (Table **7-2**).

Uncertainty erodes capacity	
	1. Uncertain relationships with healthcare providers
	2. Indeterminate waiting
	3. Uncertainty about diagnoses and health
	4. Unsure how to access care
	5. Being given insufficient information
	6. Confusion about travel
	7. Feeling helpless
Uncertainty increases workload	
	1. Fragmented care increases work
	2. Mistrust creates work
	3. Worrying about the future
	4. Carer has to fill gaps in communication
	5. Making sense of conflicting information
Coping with uncertainty	
	1. Understanding access routes
	2. Having faith in the relational network
	3. Normalising uncertainty
	4. Understanding the reasons for uncertainty
	5. Possessing material resources
Struggling with uncertainty	
	1. Disengagement
	2. Going private
	3. Being immobilised by stress
	4. Conflict
	5. Missed opportunities
Guidance through uncertainty	
	1. Improving access to care
	2. Providing reassurance
	3. Named persons
	4. Decisiveness
	5. Honesty and collaboration

Table 7-2: Thematic framework of the relationship between uncertainty and treatment burden

7.4.2 Uncertainty erodes capacity

As discussed earlier, the agency of an individual is extended through their relational network, shaped by the structure of healthcare services, and constrained by the opportunities afforded to them by these services. The functional capacity which is mobilised further relies on the ability of network members to exploit informational and material resources and to recruit support from others, while the resilience of this structure is tested by a range of health-related, relational and biographical disruptions (May et al., 2014). Social uncertainty has the potential to undermine these relationships, while physical and psychological uncertainty can erode the functional performance of network members. Disrupted or precarious flow of informational resources further impinges upon the capacity of the network, compromising its structural resilience.

7.4.2.1 Uncertain relationships with healthcare providers

Trusting relationships with healthcare providers can extend the capacity of patients and carers to undertake work, but when this trust is absent or compromised through unsatisfactory interactions or accumulated negative experiences it can frustrate efforts to express capacity. Often these negative associations are extended out to whole clinical areas, facilities, or the health service as a whole. Some wards are ‘bad’, others are ‘good’, an entire GP surgery may be viewed as unhelpful, or the NHS seen to be acting in a self-interested or duplicitous manner. Andy felt that most interactions with health services were unsatisfactory, and this had led to a fundamental mistrust of the NHS:

> I don't know what the Government are up to, because I feel as if there's some kind of way, right, they're trying to reduce the number of people, to be honest with you. And they're basically taking their eye off the ball with people, putting in a disease saying, COVID, so that they can just basically get the population down. That’s my own personal opinion, I don't know. [Andy]

When healthcare providers, services and the NHS as a whole are viewed with such scepticism, patients and carers are less likely to engage in the act of building and maintaining beneficial relationships with providers. As such, their capacity to act is undermined.

7.4.2.2 Indeterminate waiting

Waiting on appointments, waiting for transport, waiting to be seen or admitted in the ED; all such waiting tended to be indeterminate in nature. In the absence of a finite end-point the burden of waiting is not only temporal, but requires the patient and carer to maintain a state of vigilance, simultaneously ready to act and unable to do so.

Figure 7-12: Sketch of waiting from Bill's journal

Barbara and Theresa reflected on this when discussing a recent visit to the ED. While they were broadly understanding of the reasons why they spent several hours in the department, Theresa described how she felt unable to leave Barbara in case she had to be present to answer questions or relay information to the wider relational network. Actions such as getting an overnight bag, having meals or potentially arranging transport home were postponed as they waited for information:

> We didn't know how long it was going to be. It was one of those situations where you're not thinking ahead because you think it is going to be any minute, and it isn’t any minute, you know, you're doing this, that and the next thing, and then you look at your watch and my goodness, I wondered why I was absolutely starving… [Theresa]

7.4.2.3 Uncertainty about diagnoses and health

The ways in which uncertainty about diagnoses, conditions, procedures, medications and the like can erode capacity are predominantly related to either poor flow of information from healthcare providers or uncertainty on the part of the providers with relation to disease progression or treatment outcomes. This prevents the patient and their network from being able to plan ahead, and therefore from taking action.

Ruth developed a cough after her cancer treatment, but when asked if she knew if this related to the treatment she was uncertain:

> I don’t know. They don’t tell you that. That’s the only other thing. When you go…when you’ve got the cancer, you go…the…you're under the impression…when you get the operation and then you go for the radiation, some get chemo, you think that’s it finished. You don’t realise the side effects of all these pills that you're on for five years. I mean, I’ve said before and I’ve heard people saying it, the cure’s worse than the cancer. [Ruth]

Whether this was due to an omission on the part of her clinical team or simply unforeseen by them, she felt unprepared for this side effect and the ongoing effects of her cancer treatment.

7.4.2.4 Unsure how to access care

Uncertainty over how to access care limits capacity through the simple mechanism of preventing patients and carers from accessing the right service for the right condition at the right time. Attending an ED and waiting hours to be seen when something can be handled by a call to the GP, or deferred booking of an appointment due to uncertainty about referral pathways are examples of this. Bill had been instructed to contact a 24-hour helpline during his cancer treatment should he develop certain side effects. However, when he did become unwell he tried to contact the helpline and on hearing a pre-recorded message, hung up and waited till the morning. It was unclear whether he would have been able to leave a message and be called back through the night, but the disparity between what was expected (a manned phone line) and what was available meant that Bill was left unable to take action, deferring treatment and necessitating a further call in the morning. Bill reflected on this:

> The wee card said it: you must phone us immediately, night or day. Now, in my mind, that's a failure if there's no live person at the phone at night-time. I told the girl I spoke to in the morning. [Bill]

7.4.2.5 Being given insufficient information

The mechanism through which insufficient information limits capacity is also simple; patients and carers cannot engage with work when they lack the information required to conceptualise the work. The most common example of this related to medications. Patients were often on medicines which they were unable to understand fully why they were taking them. Conversely, medications may be stopped or temporarily withheld and patients were similarly confused. Being unprepared for side-effects (due to an omission on the part of clinical staff) can also be considered as an example of being provided with insufficient information. Mel recounted medicines being stopped by the hospital and her GP being unable to explain why but refusing to re-start the prescriptions. This placed her in a position where she was unable to resolve the situation due to poor informational flow from healthcare providers. Frustrated, she tried unsuccessfully to get involved with the process of discharge prescribing:

> When I'm getting discharged from hospital, I always say to them, can I check the list of what you're putting through for the pharmacy? They always say, no, we know what you're getting. We'll give you the right things but they never ever let me check that list. I don't know why because they should do because it's my medicines. [Mel]

7.4.2.6 Confusion about travel

Getting to and from healthcare settings has featured frequently in this analysis. The mechanism through which confusion about travel erodes capacity can incorporate indeterminate waiting (being unsure when transport will arrive), insufficient information (being unsure how to get to somewhere), and uncertainty about relationships (not trusting those who are responsible for coordinating transport). Despite the multidimensional nature of this theme, its ubiquity merits distinct attention.

Ambulances were discussed often, and there was a lack of clarity over how transport was allocated and worries about getting home from hospital after an emergency attendance. Some felt that since they had been brought to hospital in an ambulance, that an ambulance should take them home. The distinction between an emergency ambulance (staffed by paramedics and technicians) and patient transport was not universally understood, and this fed into some misconceptions. Andy and Patricia had several instances where they felt poorly served by patient transport, but the differences between what is available for routine outpatient appointments and what can be achieved during an emergency attendance were unknown to them, meaning that they were surprised to find they had to wait several hours for safe transport home from the ED. The journey to the hospital was similarly fraught and ended up taking several days, with Andy cancelling the ambulance on several occasions when he felt it was too late in the evening. They had hoped to go to an ambulatory care facility and were unsure why Patricia had been taken to the ED instead; Andy blamed the ambulance:

> It took me until the Tuesday until I got my mum to the hospital because of the waiting time for the ambulance. I had to cancel it at 9:30 at night after waiting all afternoon because they said that it wouldn't be there until 11 o'clock at night and the stress could have killed her especially when they can't believe she's still alive. So when I got the doctor the next day to make sure that she wasn't waiting again because of what happened the day before. But the problem was that they had took my mum to an A&E hospital instead of taking to the minor injuries where she would have been seen quicker. But they had took her to the wrong hospital and that's when the problems started… [Andy's journal]

7.4.2.7 Feeling helpless

The final mechanism through which agency is eroded by uncertainty relates to the existential uncertainty experienced when an individual feels unable to act. Thus, an awareness of impaired capacity can itself further impair capacity. Irene reported feeling helpless at times with regard to Bill's cancer, and they both reflected on how Bill's perceived capacity (exercised by going to appointments, following treatment regimens) to an extent insulated him from this feeling of helplessness, while Irene felt that as an observer she lacked agency:

> Bill is coping, I think, very, very well with this. Because he's not a worrier, and he says, there's no point in worrying because I can't really do anything about it, everything that’s being done is being done. I mean, [Bill’s oncologist] has left no stone unturned, she's been really excellent. And he has a great trust and rapport with her. Obviously, my situation is different, I'm on looking. So, I feel out of control. [Irene]

7.4.3 Uncertainty increases workload

Not only does uncertainty erode the capacity of patients and their relational networks to undertake work, it also acts to increase the volume of work which must be undertaken, creating further imbalance.

7.4.3.1 Fragmented care increases work

Practical uncertainty (as described by Etkind et al. (2022)) relates to the ways in which people with multimorbidity and their carers can be required to navigate complicated networks of healthcare providers, treatment regimens, and guidance. This uncertainty requires organisational and surveillance work to be undertaken, with the burden of care coordination being placed on the patient and their relational network.

Examples of this work include seeing lots of different healthcare professionals, having to repeat histories, relaying information provided by one party to another, care being spread across multiple locations, and uncertainty about the roles and responsibilities of healthcare providers. Mel was in the process of moving GP, although she had little faith in seeing an improvement in continuity at her new practice. She explained how she hoped things would change, although this was expressed more as an ideal situation than a realistic prospect:

> I don’t want any other doctor to deal with my care except that doctor because that doctor will get to know me and will get to know what I need from my care package. It will always be the same doctor, so they’ll know what’s been going on with me like weeks ago or months ago or whatever because they’ll know my history inside out because they deal with me all the time. [Mel]

7.4.3.2 Mistrust creates work

In the preceding theme, the way in which relationships lacking trust can deplete capacity was discussed. Yet the harm caused by such mistrust further imbalances the scale by creating work for patients and carers. When there is a lack of trust in healthcare professionals, patients and carers may adopt some of the actions more commonly undertaken by clinical staff. Andy and Patricia are an example of this. As already mentioned, Andy did not trust the pharmacist to prepare Patricia’s dosette box, so he had taken this task on to himself. Similarly, Andy also researched treatments, drugs, side-effects and Patricia’s condition, and he would advocate for care plans which aligned with his findings. These actions were borne of Andy’s perception that the healthcare professionals couldn’t be trusted to act in Patricia’s best interest, and that they lacked the expertise to manage her conditions. When asked what sort of things he would like to see change in the way Patricia was cared for, he replied:

> Some of the doctors to be more knowledgeable. And I don't mean that in a bad way. Because I feel as if, see like, see when my mum's had cancer, I feel as if I'm actually telling the doctors exactly what to do. [Andy]

7.4.3.3 Worrying about the future

Worrying about the future is a form of psychological and existential uncertainty, and the work of worrying places a cognitive and emotional burden on the individual who is uncertain about their future or that of their loved one. Stephanie, for example, worried about getting older and how she and her husband would care for their son Nick as their physical ability to do so decreased. Irene worried about how Bill’s condition was progressing and what treatment options would be available in the future. In the same way that this uncertainty can erode capacity, the actual act of worrying increases the workload of patients and carers:

> I’ve been quite weepy, easily moved to tears, and anxious, frightened about what’s ahead of us. Which is unknown because we don’t know how this is going to progress. Do we run out of options for treatments, what happens then? [Irene]

7.4.3.4 Carer filling gaps in communication

The workload of carers can also be increased when information flow between healthcare providers and patients is compromised by uncertainty, either due to poor communication or cognitive impairment. Andy is Patricia’s primary carer and power of attorney, and he often found himself trying to fill gaps in communication, either explaining things in more detail to Patricia or reiterating things which had been covered previously. Patricia had sustained an injury from a fall, and there was suspicion that this was caused by drowsiness secondary to over-sedation. However, Andy had to mediate between Patricia and those prescribing the medication in order to ensure she understood the sedative effects and potential risks:

> [The] simple fact is with my mum's painkillers, sleeping tablets – and I've told her this before – it's not really a good combination, because the sleeping tablets being your Oxypro it can slow your breathing down as well. And obviously my mum was adamant that she wanted to take them at the beginning, but I didn't want her to take them, but I couldn't stop her. Because obviously I said to her, those two tablets together, they're not really a good combination. [Andy]

7.4.3.5 Making sense of conflicting information

The effect of insufficient information on capacity has been discussed already, but when there is a surfeit of information and some of it is conflicting, the resulting uncertainty can also create additional work. Being given conflicting advice on diet, diagnosis and drug interactions all created problems for participants, and usually resulted in patients and carers taking it on themselves to do additional research, consult with healthcare professionals or struggle to reach a decision which accommodates both conflicting recommendations.

Tom provided an example where he had been advised of a medication which had potential to cause side effects in adults his age and sought further information from the nurse practitioner in his GP surgery. However, he didn't receive a satisfactory explanation for why he was still on the drug and was told to ignore the first advice he had received. Bill had a similar experience, where he had to see a second doctor for an antibiotic prescription after the first doctor had provided treatment which differed from that which he had been prescribed before:

> Well, I took the steroids and the antibiotics, and it didn't clear it up, so I phoned back and got a different doctor. And I said to her, I've had this, it's not gone away, Doctor so-and-so gave me five days, it's no bloody use, I want seven days. She gave me seven days. So, it's now virtually away. [Bill]

7.4.4 Coping with uncertainty

The imbalance between workload and capacity created by uncertainty has been outlined in the preceding two themes. This theme is concerned with the ways that patients and carers display the ability to cope with uncertainty. There are parallels between some of the elements within Burden of Treatment Theory which extend agency and capacity (such as conceptualisation, strength of relational networks, and access to material resources).

7.4.4.1 Understanding access routes

Difficulty accessing care limits capacity, as has been illustrated. It follows then that having an awareness of how to access care may extend capacity. In addition to this, understanding access routes to healthcare and support can help patients and carers cope with uncertainty by providing reassurance that in crises they are in a position to act.

Most participants felt confident that they could do things like see specialists, increase packages of care, arrange respite or get a GP appointment, albeit with variations in the length of time spent waiting on appointments. For some, knowing that there was the opportunity to access support when needed made an appreciable difference to their ability to cope. Returning to the earlier example of Irene; after struggling to access carer support following Bill's cancer diagnosis, she eventually managed to speak to someone, and while she didn't feel like she would be using the service regularly, simply knowing it was there had a positive impact:

> So, anyway, she had a long chat and she said to me, you can come here any time you like, and I said, I probably wouldn't come down unless Bill was in treatment. And she said, no, I really mean you can come at any point that you feel you want to have a chat. [Irene]

7.4.4.2 Having faith in relational network

Similar to understanding access routes to care, having a robust and reliable relational network insulates patients and carers from some of the uncertainty which can destabilise the balance between workload and capacity. Potential disruptions may be abstract and unforeseen, but the relational network may also provide a guarantee of support in anticipation of expected or vaguely-foreseen crises. For example, Tom and Ruth spent a lot of time abroad in their holiday home and the risk of Ruth becoming unwell due to her medication was ever present. Reluctant to access potentially costly healthcare services abroad, they felt comfortable that they could get a short flight home and irrespective of where they landed in the country, family members would come and pick them up:

> Ruth: …if you don't get Glasgow, you just go to any airport. As soon as you get home, we've got family that'll pick us up.
>
> Tom: Yeah. And plus you've all got Scotland…you've…either Edinburgh or Prestwick, somebody can go down there and pick you up.
>
> Ruth: Even Newcastle's not far…

7.4.4.3 Normalising uncertainty

There were various ways in which people displayed having normalised living with uncertainty to the extent that it no longer held the disabling effects described earlier. Often this was simply through repeat exposure to crises resulting from uncertainty, such as repeat hospitalisations for Mel, attending the ED due to drug allergies for Ruth, or Stephanie attending to Nick when he develops a chest infection. Skills were developed to handle these crises both through repeat exposure, or through formal education and training (in the case of Stephanie the healthcare professional). In other cases, accepting and normalising uncertainty appeared to be a product of an individual's outlook or personal philosophy. Continuing on the theme of holidays and travel, Bill and Irene discussed the need to take a break within the UK during a gap in Bill's cancer treatment, but Irene worried about what would happen if Bill became unwell. Bill's equanimity to the problem, and the way he had normalised living with uncertainty allowed him to dismiss this suggestion:

> Irene: And yes, we would have to fly down to Southampton or wherever, that would be fine. But I'm also a bit worried about that, that you have a bad turn and we're stuck somewhere.
>
> Bill: [said jokingly] Well, there are hospitals down there.

7.4.4.4 Understanding the reasons for uncertainty

Having knowledge of the reasons for uncertainty does not in itself remove uncertainty. It is possible to know that a condition may worsen or that a drug may cause side effects, but the probabilistic nature of this knowledge still allows for the presence of uncertainty. Awareness of this precarity and the mechanisms which are responsible for it still provided patients and carers with the capacity to tolerate uncertainty. Differing responses to indeterminate waiting are a useful illustration of this. Some struggled with this, unable to conceptualise the reasons why patient transport took so long, or why it took longer than expected to get medicines in hospital. Others who were aware of the reasons for these periods of waiting (short-staffing, prioritisation of emergency transport and the like) appeared better equipped to tolerate the uncertainty:

> …I understand the nursing staff, the medical staff and porters and the cleaning staff are absolutely fantastic and [my husband] and I can't praise them enough. But everyone is so stretched, you know, in hospitals, and I completely appreciate that it must be so frustrating for staff working there 'cause it's so short staffed. [Stephanie]

7.4.4.5 Possessing material resources

Finally, as is the case with capacity in relation to treatment burden, access to exploitable material resources can help patients and carers tolerate uncertainty. Bill and Irene acknowledged that their financial position meant that they were able to do things like afford travel to appointments or pay a cleaner so Irene had more time to support Bill. But they also reflected on the fact that these resources meant they were able to weather future disruptions. Bill found gardening therapeutic but felt physically unable to do certain heavier tasks, so a neighbour helped out and they also paid a gardener. This meant that Bill could focus on the tasks which helped him exercise and those which were good for his emotional and mental health, without worrying about the overall maintenance of a large garden. Thinking ahead to a time when Bill may need a bit more help or they were unable to rely on help from neighbours, Irene was comfortable that they could still secure help while supporting Bill to enjoy working in the garden:

> We can afford, fortunately, to get more help if we require it. [Irene]

7.4.5 Struggling with uncertainty

While some were able to insulate themselves from the effects of uncertainty by leveraging material, relational, and informational resources as well as past experiences, others struggled. This theme is concerned with the negative effects which resulted from intolerable uncertainty. These include disengaging from services, failing to access them in the first place, or using financial resources to access care which should be available from the NHS. Some were also driven to inaction or decision deferral by complexity and conflict. Not only do these effects evidence the imbalance between workload and capacity, but they also serve to widen the gap between what must be done and what can realistically be achieved.

7.4.5.1 Disengagement

Disengagement with a service takes place for a number of reasons: social uncertainty about the ability of personnel to provide adequate care, practical uncertainty about the coherence of service delivery (i.e., care has become fragmented), or existential uncertainty and feeling overwhelmed by the complexity of care. In some cases, this rejection of a service stems from multidimensional uncertainty comprising several factors. Mel had become involved in litigation with her GP surgery, feeling that she had suffered harm as a result of overprescription. She doubted the competence of the individuals involved, and complained about the way the practice was structured so that she couldn’t change her surgery without moving house. On top of this, she felt that the complexity of her medications was overwhelming, and that the surgery were unwilling to assist her by de-prescribing those which were non-essential. The result was Mel’s disengagement from the surgery:

> I mean I’m suing my doctor at the moment. I’ve just changed my doctors as well there to a different one in the health centre because I tried to get rid of the health centre completely but that’s the only health centre that will take on this postcode, do you know what I mean, so I’ve got to go with a surgery in that health centre… I didn’t want to be with that health centre full stop. [Mel]

7.4.5.2 Going private

All people in the study were UK citizens, registered with a GP and resident within the NHSGGC health board. As such, access to primary and secondary care through the NHS was available to everyone for all procedures discussed in this study. Patients can elect to use private healthcare services to access treatments which are not provided by the NHS, or to expedite access to specialists. However, there were instances where participants decided to pay to use private healthcare services for appointments or procedures which could have been provided by the NHS. This is a form of disengagement, but one which merits individual attention owing to the fact that it is costly, and represents a system where those with financial means have greater capacity to act than those without. Indeterminate waiting for appointments was a common driver of private health care use and was not limited to those who identified as being financially secure. Andy and Patricia seemed particularly affected by this, and had on multiple occasions paid directly to see specialists when confronted with lengthy or open-ended waiting times. However, this sometimes resulted in simply adding confusion:

> I’ve been sitting waiting from September for an appointment. So, I eventually had an appointment for [the private hospital], then I got an appointment through from the [NHS] so I cancelled the appointment for [the private hospital] ’cause it was costing me £150. So, I thought, why should I pay that? So, I cancelled the appointment, then the next day I got a letter out saying they cancelled my appointment for the hospital. [Andy]

7.4.5.3 Being immobilised by stress

Stress has been discussed earlier, particularly in relation to how it can compromise structural resilience when a carer is worried about a loved one. Stress resulting from uncertainty can become overwhelming and can in effect immobilise relational network members, preventing them from taking action. Scott worried about Mel, particularly when she was admitted to hospital. There had been uncertainty surrounding diagnoses, discharge drugs, and the extent to which healthcare staff were trustworthy. Mel, through repeat exposure to the hospital environment, had developed a form of resilience to these stressors. Scott however, felt immobilised and overwhelmed by his worries, as noted by Mel:

> it's normal for me to go into hospital and have issues with a doctor coming in one day and telling me you've got something, and then another doctor coming in another day and telling me, no, you've not got that, you've got that. Then the third day, you're told a third thing and you're thinking, well, what is it that I've got? So I think Scott suffers more than what I do, yet it's me that's got all these conditions. [Mel]

7.4.5.4 Conflict

The effects of conflict between patients and healthcare providers in relation to uncertainty are multidimensional. As has been addressed earlier, if relationships are damaged by conflict, then the ability to exercise capacity is compromised. Furthermore, this can increase work by making the patient and carer assume responsibilities which they no longer feel confident delegating to healthcare providers. The final mechanism to be considered is the way that conflict can be symptomatic of an exceeded threshold of uncertainty tolerance. Mel's relationship with healthcare teams (particularly in relation to medications) provides an example of all three mechanisms. Communication with primary care is limited due to a fractious relationship with the reception staff (limiting capacity), and Mel has begun trying to organise her own medications due to her not trusting the hospital to do so correctly (increasing workload). Finally, the culmination of these mechanisms is that Mel feels compelled to become involved in litigation with her GP surgery, providing evidence that her ability to tolerate the uncertainty surrounding her treatments has been exceeded:

> I've got a liability claim going on at the moment against my doctor and it's basically because he wouldn't prescribe me the water tablet. When I went into hospital with the over-fluid, he went, why didn't you ask your GP for a water tablet? I said, I've been asking my GP for three months for a water tablet. My GP won't give me one. He went, why not? He said your kidneys are 100 per cent. I said, because he said it could affect my kidneys. He said, well, you were on one before. I said, I know. He said, well, why did you come off that? I said, I don't know. [Mel]

7.4.5.5 Missed opportunities

The final way in which overwhelming uncertainty was displayed was when it simply prevented participants from accessing services which could be of benefit to them. The mechanisms through which disengagement occurs can also create missed opportunities, however in dealing with services which have not yet been accessed, there is also the potential for an accumulation of uncertainties to prevent participants from taking action. Irene accessed caregiver support services for the first time during the study, having felt that she could have benefitted from them at an earlier point (Bill was diagnosed with cancer a year earlier). This missed opportunity was not simply the result of poor informational flow, difficulties with travel, uncertainty about clinical staff, or just worrying about the future and how Bill's cancer would progress; it was an accumulation of all these factors, amounting to an intolerable degree of uncertainty. Irene noted (making reference to a conversation she had with a staff member) once she had been made to feel welcome and reassured that she could make use of the service, she was able to understand that the small uncertainties (such as parking or locating the clinic) may have been overcome earlier:

> So, she took me to a wee area, and we sat and chatted, and I told her what was happening. And I said, you know, it's a year, and she said, and you're only finding us, and I said, yes. And she said, God, that's awful. Partly maybe my own fault for not looking more at the leaflets and things on the ground floor. [Irene]

7.4.6 Guidance through uncertainty

The final theme relates to the role played by individuals – healthcare staff – in helping to guide patients and carers through the total uncertainty associated with multimorbidity. Again, drawing on concepts outlined by Burden of Treatment Theory, this theme outlines the ways in which having a proactive, decisive and trustworthy named individual who can facilitate better access to care and offer guidance and reassurance can both extend capacity and reduce workload. It is noteworthy that many of the examples in this theme relate to cancer care; both oncologists and cancer nurses were often identified as examples of people who helped guide patients and carers through uncertainty.

7.4.6.1 Improving access

Having trouble accessing care limits capacity, therefore when clinical staff were able to facilitate easier access to care or were themselves easy to reach, it was appraised positively by patients and carers. In the cases of cancer nurses, being able to reach them easily over the phone was appreciated. For Bill, as discussed earlier, his oncologist was proactive in contacting him and following him up even when he was admitted to hospital for reasons other than his cancer.

Where the benefits of having someone who can facilitate access was most apparent was when normal routes to care became fragmented. Ruth had been struggling to get a GP appointment and had become frustrated by her interactions with the receptionists, so she instead made an appointment with the asthma nurse (with whom she had a trusting relationship) who then arranged for her to see the GP:

> I tell you, one of the times the receptionist, I couldn't get past her. I kept asking for a doctor's appointment. And, what are you wanting a doctor for, he'll phone you. I said, I really need an appointment. And I ended up…I said to her, look forget it, can you make me an appointment with the asthma nurse, 'cause I've got asthma. And when I went to… the asthma nurse, and I said to…she went, what's wrong, is your inhaler not right, I says, no nothing to do with my asthma, I said, but I couldn't get an appointment, I just made the point of asking for you. And she laughed. And she went, I don't blame you. See trying to get past the receptionists… [Ruth]

The unfortunate effect of this is that both Ruth and the asthma nurse's workloads were increased due to the problems getting a GP appointment. Had she been in a position to leverage the skill-set of this individual without making the unnecessary appointment, both parties would have benefitted.

7.4.6.2 Providing reassurance

The destabilising effects of living with uncertainty can immobilise and overwhelm, or they lead to disengagement, mistrust and conflict. A means through which healthcare providers can mitigate these harms is by providing reassurance either about the reasons for uncertainty or that help is available when needed. Returning to the example of Patricia's recent admission to hospital, she had been left feeling extremely unhappy with how she had been cared for. Both Andy and Patricia felt that she waited too long on medications, and that the staff were not able to provide adequate care. The driving factor behind Patricia's desire to avoid a further admission (transport was only booked after lengthy discussions about whether she could be discharged, potentially increasing the delay they experienced), was that she was adamant she would not be readmitted to this particular ward. However, she suffered a period of ill-health and was unable to avoid admission, although she was glad to be admitted to a different one than previously. The distinction between how Patricia felt she was cared for in each ward is stark, and the reassurance offered by the staff in the second ward (that medication would arrive on time, that she would be able to get a cup of tea) served to completely change her perspective on inpatient care:

> I told that staff nurse, I said, I'd never come back, but I said, I tell you now, if I had to come into the hospital, as long as I know they're putting me into your ward, I'll come in. I would come in, I wouldn't have any problem. [Patricia]

7.4.6.3 Named persons

There were several examples of named individuals who were seen as instrumental in helping patients and carers navigate uncertainty. The ease with which Bill could rely on his oncologist, Ruth on her cancer nurse, or Barbara on her GP, was made clear throughout. Yet the function of these individuals in dealing with uncertainty was not purely related to their clinical expertise, but due to their availability and accountability to the individual patient and carer. Continuity mattered, and the knowledge that someone who knew the patient and carer was available and would continue to be there throughout their illness was a source of reassurance. Bill reflected on the role which used to be occupied by a hospital almoner. The almoner was an individual responsible for the social and pastoral wellbeing of patients and their families; it was a role which existed in the NHS until the 1960's before being absorbed by the more generic practice of medical social work (Nottingham and Dougall, 2007). Again to use a negative example, Bill and Irene felt that during an emergency admission, many of the things that went wrong (Irene being left alone in a waiting room, Bill having information relayed second hand by Irene) could have been avoided had there been the equivalent of an almoner in place. The need was not for clinical ability, but for a named person who could provide pastoral support in times of crisis:

> …there should be the equivalent of the almoner who is introduced by the medical person. This is Mr so-and-so, Miss…Mrs so-and-so, she'll go off with you and have a coffee or a tea and explain what's going to happen and how we can help. So, what it is, is proactive rather than

> reactive. And that requires a fair degree of training of the personnel involved to achieve that. [Bill]

Importantly, Bill felt that the individual should be trained in a specific set of skills to allow them to do this task, rather than it falling to someone or several persons who were also trying to balance clinical duties with their responsibility to the social and emotional wellbeing of the patient and carer.

7.4.6.4 Decisiveness

At its core, uncertainty impedes an individual's ability to take decisive action. Patients and carers who had links to healthcare providers who could help shoulder the burden of decisions and take action viewed this as a desirable characteristic. There were concerns that clinical staff were often restricted by following protocols and a fear of being held accountable for any deviations from normal practice. Often the uncertainty caused by this indecision related to seemingly common-sense problems. Returning to Bill's recent admission when he spent more than six hours waiting on discharge medications, Bill lamented that the clinical staff could easily have expedited his discharge but were ultimately confounded by this fear of taking responsibility:

> I've seen it elsewhere – that's not really my job – and I'll hide behind it not being my job. [Bill]

He drew comparisons with the military, and how more senior soldiers with experience of battle would be the best equipped people to make decisions, often more so than the officer responsible for the unit:

> …if a situation arises, and the lieutenant who's in charge of the platoon would immediately turn round and say, Sergeant, what should I do. Because they're young, they're inexperienced, whereas the sergeant has probably been there longer and has probably heard the sound of bullets flying past his head. [Bill]

What Bill is exemplifying is that the capacity to act and make decisions is not directly associated with hierarchical seniority within an organisation but relates more to knowledge and experience.

7.4.6.5 Honesty and collaboration

Much as decisiveness is seen as a desirable characteristic in a healthcare professional when trying to navigate through uncertainty, patients and carers do not want to be deprived of their agency to make decisions about their care. In order for this to happen, the relationship between patient and healthcare professional must be collaborative and founded on honest communication. This involves firstly establishing what level of collaboration is acceptable. In Bill’s case, his oncologist had a frank but important conversation with him about life expectancy, which allowed them to move forward with his treatment with an understanding of what Bill understood and hoped to achieve:

> She said to me, can we, would you like to talk about time. And I said, is there any point in not talking about time, and she said, what would you hope for. And I said, well I'm 78, if I could get five years, I'd be happy. [Bill]

Stephanie also felt better looking after Nick when she knew that the clinical teams in the hospital were involving her in decisions and providing her with updates. Nick’s oxygen saturations often fell below what would be normal for someone his age, but both Stephanie and Nick’s consultant were in agreement that a lower threshold was acceptable. This was communicated to nursing staff, and helped reassure Stephanie that Nick wouldn’t need an oxygen mask, which he tolerated poorly:

> [the doctor] was very good and said, you know, that…he was fine, he said, there was no problem at all with, you know, with that. And he was happy to accept a lower oxygen saturation. And as I say, he said he would let the nursing staff know. So that was helpful. [Stephanie]

7.5 Pulling the theory together: a model of uncertainty and treatment burden in multimorbidity

In this final section, the aim is to draw the findings of this thematic analysis together into a micro-range theory which explains the relationship between uncertainty and treatment burden in people with multimorbidity. Figure 7-13 outlines a conceptual model of this relationship, and proposes that through interventions which manage uncertainty and burden it may be possible to offset the psychological harm which can lead to further disengagement and worsening of patient outcomes.

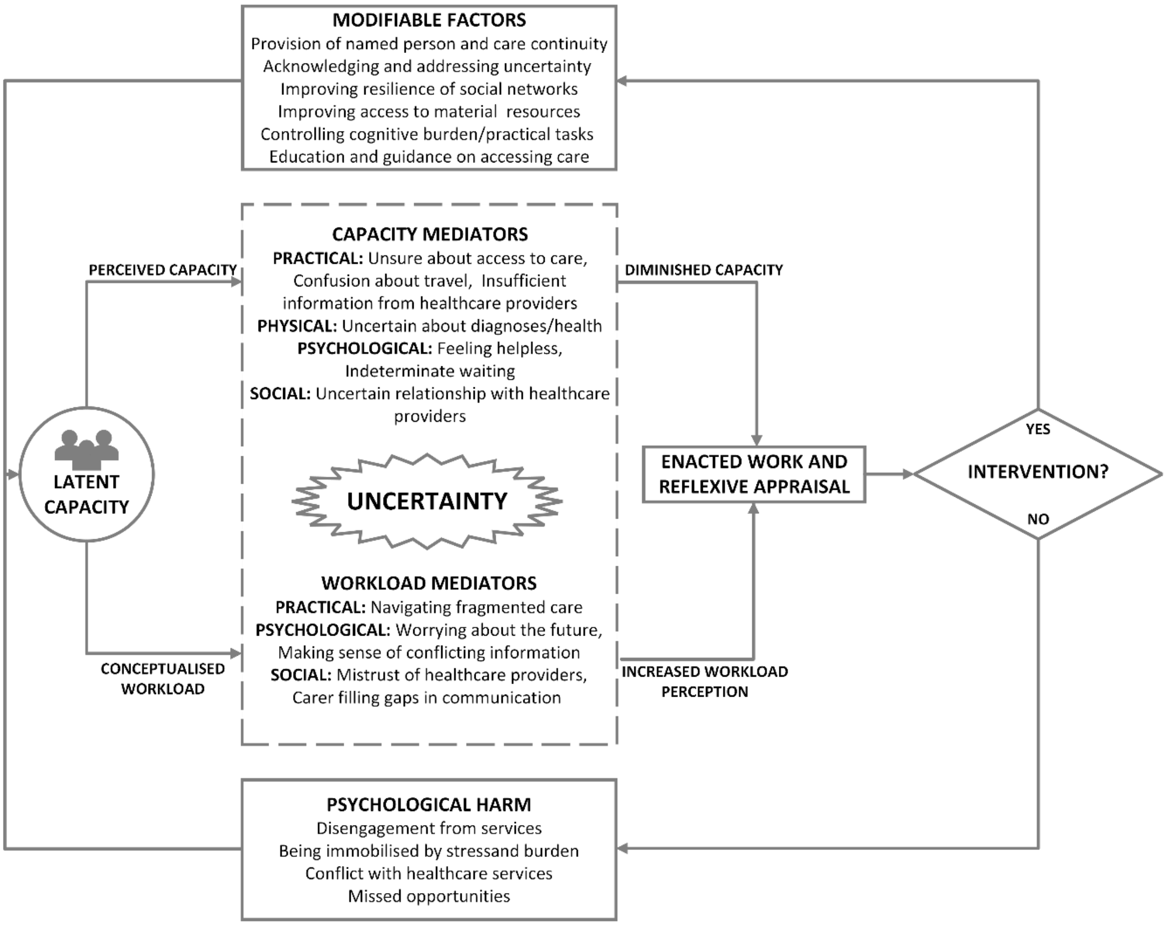


Figure 7-13: Conceptual model of the relationship between uncertainty, capacity and workload.

The latent capacity of patients and their relational networks can be understood using the generative mechanisms described by Burden of Treatment Theory (May et al., 2014). The perceived capacity and conceptualised workload of these networks are mediated through the experience of multidimensional uncertainty, resulting in diminished capacity and a perceived increase in workload, which can have a negative effect on the ability to engage with delegated work, and the reflexive monitoring of how successful this work is. Without intervention, this can lead to cognitive, emotional and behavioural responses which can worsen outcomes, such as disengagement, being immobilised by stress and burden, deterioration of relationships with healthcare service, and missed opportunities to engage with useful services. This in turn feeds back into the latent capacity of the network.

There is scope to intervene, however. Combining the recommendations made by May et al. (2014) with the findings of this phase of the thesis, it is possible to identify priorities for interventions which aim to balance workload and capacity, while also recognising the potential harm caused by uncertainty. Interventions should provide continuity, ideally through a named person responsible for care coordination. They should acknowledge uncertainty and aim to address the reasons for it. Relational networks and the flow of material resources are important too, and these should be reinforced where possible. Through discussion with patients and network members, it is also important to control the practical and cognitive burdens placed on them to avoid overwhelming capacity. Finally, any intervention must help people with multimorbidity and those who care for them to navigate the complexities associated with accessing care. In this way, interventions can help maximise the capacity of patients and their relational networks to cope with the burden of treatment and the total uncertainty which can otherwise overwhelm and undermine attempts to engage with delegated work.

7.6 Chapter summary

This chapter has detailed the findings of the focussed ethnographic study of people with multimorbidity and palliative conditions, and their carers. It sought to explore how people with multimorbidity experienced treatment burden, what role carers played, and what aspects of care could be improved.

Burden of Treatment Theory (May et al., 2014) provides a framework through which the dynamic process of balancing workload and capacity can be understood. The practical work of patienthood comprises interactions with healthcare services, managing drugs and treatments, maintaining diet and exercise, surveillance of conditions and a constant process of organising care. Yet the capacity to undertake this work is dependant on the extent to which capacity can be mobilised and extended through relational networks and through the services provided. Relational networks are often dyadic at a primary level, but there are also variations within the wider network which impact upon capacity.

The concepts of total uncertainty (Etkind et al., 2022) and uncertainty tolerance (Hillen et al., 2017) should also be considered when planning care for people with multimorbidity. Uncertainty and treatment burden intersect at various points, and through understanding these interactions it may be possible to provide better, patient-oriented interventions for this group. This chapter proposes a conceptual model for how these phenomena interact, and provides recommendations for how interventions can be structured to improve the quality of care for this patient group.

Chapter 8. Discussion

8.1 Introduction

The aim of this thesis has been to develop a nurse-led intervention for people with multimorbidity and palliative conditions. Over the three phases of the research, the problem of how to provide care to this group has been addressed from different perspectives, each phase informing not only the following phases, but also the shape of the proposed intervention. This chapter will discuss these findings with reference to what is already known, and highlight the unique contributions made by the thesis. It will also outline the proposed model for a nurse-led intervention for people with multimorbidity and palliative conditions.

8.2 Summary of principal findings

This section provides a brief summary of the principal findings of the research and explains how these relate to the intervention.

8.2.1 Phase 1: Mixed-methods systematic review

The mixed-methods systematic review determined that a variety of nurse-led interventions for people with multimorbidity existed, and that these predominantly focussed on the coordination of care, either in the form of long-term case management interventions, or shorter-term transitional care interventions. The effects on outcomes were mixed, although a summary of these would be to say that they are acceptable to patients and may have a positive effect on patient-oriented outcomes such as quality of care or health-related quality of life. The evidence to support their effects on service-level outcomes (such as healthcare use or costs) was more limited. Patient identification methods were also varied, but a significant number of interventions deployed predictive models to identify potentially intensive users of healthcare services, rather than relying on disease thresholds such as two or more conditions.

In terms of intervention design, these findings provide a guide for the broad type of intervention. Focussing on care coordination means that an intervention can be of value to people with multimorbidity irrespective of the combination of conditions they have. Careful selection of outcomes by which the intervention would be assessed is a more complex matter. It has been noted previously that complex interventions for people with multimorbidity often fail to generate positive effects in RCTs, and this is possibly due to the effects of such interventions not being detected by the selected outcome measures (Fortin et al., 2022). The Core Outcome Set for Multimorbidity Research (Smith et al., 2018) provides a range of outcomes which should be measured in evaluating such interventions, but there is also a potential need for qualitative evidence and exploratory research to understand what works for patients and what they feel is missing from their current care (Fortin et al., 2022).

This conclusion informed the design of the qualitative phase of the thesis, which sought to understand treatment burden from the perspective of people with multimorbidity and their carers. The use of predictive models using routinely collected data also informed the line of enquiry taken in the second, cross-sectional phase of the thesis.

8.2.2 Phase 2: Cross-sectional study of ED attenders

In the cross-sectional study of ED attenders, a significant association was noted between multimorbidity/complex multimorbidity/disease count and healthcare use, both in terms of admission to the hospital from the ED and return attendances within 30 or 90 days. There was no significant association noted with inpatient mortality. Crude comparisons show that people with multimorbidity and complex multimorbidity are more likely to die within 30 days, 6 months or 12 months, but these associations are not significant when comparing differences between people who are admitted.

Had there been a strong association between these exposures and inpatient mortality, then a possible direction for the intervention could have been the coordination of care around end of-life-care in the inpatient setting. The literature shows that people with multimorbidity comprised of palliative conditions are more likely to be admitted to a ward or ICU through the ED in the last 30 days of life (Wagner et al., 2019), and that this population will grow significantly in Scotland over the next few years (Finucane et al., 2021). However, this study did not detect such an association in the generally multimorbid population of ED attenders. It did detect that multimorbidity, complex multimorbidity, and disease count were significantly associated with healthcare use, and this provides a rationale not only for including these variables in predictive models, but also for focussing on the burdens associated with healthcare use (treatment burden) in the final phase of the thesis.

8.2.3 Phase 3: Focussed ethnography (the EMBARQUE study)

The focussed ethnographic study further added to the evidence of how capacity and workload interact and how the relational network (which was conceptualised at primary and secondary levels) helped to extend capacity, as outlined by Burden of Treatment Theory (May et al., 2014). This phase also revealed the way that uncertainty (building on the work of Etkind et al. (2022) and Hillen et al. (2017)) interacted with Burden of Treatment Theory to further destabilise the balance between capacity and workload. A conceptual model of this relationship (accounting for the effects of an intervention) was developed.

What this means for the proposed intervention is that the issue of multidimensional and potentially overwhelming uncertainty needs to be addressed alongside treatment burden. Care coordination and case management lends itself to this, aiming as it does to coordinate complexity in a patient-centred and tailored manner. However, a more direct approach may be useful. In Scotland, anticipatory care planning is a well-established process through which people (not just those with palliative and end-of-life-care needs) are involved in making decisions about how they would like to be cared for in the event that they lose the capacity to do so (Thomas and Russell, 2023). Part of this process involves the co-creation of a document (My ACP) which the patient keeps, and can be used to communicate their wishes (Healthcare Improvement Scotland, 2023). A similar document may be a useful way of exploring the multidimensional nature of uncertainty in the context of multimorbidity and treatment burden, although the creation of such a document should be undertaken in partnership with patients and carers.

8.2.4 Summary of relationship between findings and decisions

Table 8-1 provides an overview of the key findings from each stage of the thesis and links these to decisions made and how they affected the design of an intervention or later stages of the thesis.

Principal findings	Decisions about rest of thesis	Decisions about intervention
Phase 1: Most nurse-led interventions for multimorbidity are care-coordination-type interventions (i.e., case management or transitional care)	Qualitative phase (phase 3) of thesis should consider the burdensome effects of complex care.	The intervention should focus on care coordination and reducing the complexity of care.
Phase 1: Nurse-led interventions are well-received and may improve some patient-centred outcomes. There is less evidence of their effects on health care use or costs.	Quantitative phase (phase 2) should explore association between multimorbidity and healthcare use.	Careful consideration required about how intervention should be evaluated.
Phase 1: Most interventions are targeted at high-intensity users of healthcare and make use of predictive models without a focus on disease-count.	Quantitative phase (phase 2) should explore the utility of multimorbidity as a predictor variable.	Intervention should make use of predictive modelling to identify those who may benefit.
Phase 2: Multimorbidity/complex multimorbidity/disease count are strongly associated with health care use (admission and 30 or 90-day reattendance) in ED attenders.	Qualitative phase (phase 3) should focus on effects of health care use.	Predictive models should be used to target potential high-intensity healthcare users.
Phase 2: There is no significant association between multimorbidity/complex multimorbidity/disease count and death during admission.	Qualitative phase (phase 3) should maintain focus on people with palliative conditions but not necessarily those approaching the end of life.	Inpatient end-of-life care should not be a priority for the intervention.
Phase 3: Burden of Treatment Theory provides a framework through which the balance between workload and capacity can be understood in people with multimorbidity and palliative conditions and their carers.	N/A	Burden of treatment must be considered in intervention, and carers must be involved.
Phase 3: Multidimensional and potentially overwhelming uncertainty diminishes capacity and increases workload.	N/A	Assessment of uncertainty and its sources should form part of intervention.

Table 8-1: Summary of principal findings and how these relate to key decisions made during the thesis.

8.3 Strengths and limitations

Before contextualising the findings of the thesis in relation to what is already known, it is important to address the strengths and limitations associated with each stage of the research.

The mixed-methods systematic review was the first such review of nurse-led interventions for people with multimorbidity which focussed on (i) any type of nurse-led intervention, and (ii) general multimorbidity (excluding studies where evidence was based on comorbidity studies). Reviews have been conducted which are adjacent to the one presented here, but which do not meet these criteria, for example Lupari et al. (2011)'s review of nurse-led case management interventions for people with multimorbidity, which included several studies focussed primarily on comorbidities or assumed multimorbidity in older adults. The review presented in this thesis was also conducted following a rigorous methodology (JBI), and the protocol was pre-registered to ensure transparency.

A potential limitation of the review is one which it shares with other systematic reviews relating to multimorbidity. On one hand, the historic reporting of multimorbidity in research is poor, as clinicians and researchers often fail to make the distinction between comorbidity and multimorbidity (Harrison et al., 2021). On the other hand, since the introduction of a MeSH term in recent years (Tugwell and Knottnerus, 2019), use of the term multimorbidity has increased, although often it is referred to by authors in titles and abstracts without it actually being the focus of the research (Ahmed et al., 2020). This means that reproducibility of searches and screening can be difficult. Efforts have been made to compensate for this here by thorough reporting of how the searches and screening were conducted, both in the thesis and the published paper.

A strength of the cross-sectional study is that it is (to the author's knowledge) the first exploration of multimorbidity, complex multimorbidity and disease-count in a population of ED attenders which used validated algorithms to identify common chronic conditions. One study from France was published in the same year with a similar-sized population; however, this study explored multimorbidity clusters and the effects of a new unscheduled care service on the types of ED presentations (Wartelle et al., 2022). A strength relating to the use of validated and reproducible algorithms is that comparisons can be made between the study presented in this thesis and others which have used the same algorithms, including Tonelli et al. (2016) and Stokes et al. (2021). The study also used a full 12-month period in order to capture seasonal variations in the type of attendances.

A limitation of this phase of the research relates to the relatively short-term historical inpatient data available. As a result of the COVID-19 pandemic, this study was brought forward in the research programme to increase the likelihood of being able to recruit from the ED during the qualitative phase of the thesis. To expedite this phase, access to an existing data extract was negotiated in order to conduct a secondary analysis, rather than producing data extracts to study specifications. Fortunately, the extracts contained all the data required, but with a shorter 'look-back' period to detect conditions from historical inpatient data; more than five years would have been preferable, but the study presented here only had access to around 21 months for some cases. This means that the true prevalence of multimorbidity is probably higher than estimated by the study. In order to avoid biased over-detection of conditions in people attending towards the end of the study period (who would have access to around 12 months more historical data when compared to those attending at the start of the period), the decision was made to restrict all cases to a 21-month look-back period. What this means, however, is that the algorithms can still detect significant associations with limited historical data, which may be a strength in terms of computational demands if they are deployed real-time as part of a predictive model.

Another limitation is that the original algorithms were validated in a different population and in a different healthcare system (Tonelli et al., 2016). Differences exist between coding practices dependant on how healthcare is provided in that country (for example reimbursement versus universal provision), so further validation of whether the conditions identified by the algorithm represent what would be elicited during clinical examination and history taking is required in this population, particularly if the findings are used to inform clinician-administered risk-stratification scores rather than data-driven predictive models.

A strength of the qualitative phase is that it involved a diverse population of patients and carers with a wide range of chronic and palliative conditions, including adults with incapacity. It also allowed participants to provide data without mediation of an interviewer (through journalling), and the repeated interview methodology meant that themes which were identified during the initial analysis could be revisited and questioned during the closing interview. Visiting participants in their own homes and in their local area meant that valuable contextual information could also be gathered. Similarly, meeting and speaking with participants in the ED provided a useful background to their experiences of care, and in many cases this meeting helped shape the enquiry. The analysis was theoretically-grounded, both a priori and through the introduction of other concepts during the analysis (i.e., uncertainty). The output of the analysis includes a conceptual model grounded by these theories which can be used to explore the relationship between treatment burden and uncertainty in future qualitative work.

The sample size of 12 was at the lower end of what was intended, and the end of recruitment was determined by the timescales of the project. There is a tendency in the reporting of qualitative research to claim ‘data saturation’ as the guiding principle in decisions about when to stop collecting and analysing data; however, the utility of this concept in reflexive thematic analysis is disputed by Braun and Clarke (2021), and it is arguably at odds with the assumptions of critical realism. Claiming to achieve saturation risks implying a naïve realist ontology in which meaning is resident in the data, and that it is passively excavated by the researcher (Braun and Clarke, 2021). As covered earlier in the thesis, the meta-theoretical position here assumes a realist ontology in which observations are limited to the empirical realm (the *real* being inaccessible), and that epistemic activity involves a retroductive process of reasoning in which the validity of a given theory is in its capacity to explain observed phenomena in a coherent manner (Bhaskar, 2013). In this regard, the sample size of 12 was sufficient to meet the aims of the research.

It is also worth considering the challenges which were encountered in securing approval to conduct the study, and how the scope of observation and the means of communication with participants was limited during this process. It was still possible to conduct a focussed ethnographic study, but had more observation in naturalistic settings been permitted (such as in clinical areas), it may have been possible to gain a better understanding of how treatment burden is experienced.

Another possible limitation is that in a study which included carers, there was no specific application of theory related to caregiver burden. When comparing the concepts of treatment burden and caregiver burden there is considerable overlap; the main difference between the two being that caregiver burden is also concerned with issues around carer’s sense of self, but they both represent dynamic, multidimensional phenomena (Liu et al., 2020; Sav et al., 2015). The argument for excluding specific theories related to caregiver burden is based on the fact that Burden of Treatment Theory is a structural model which includes the role of relationality, and at different levels the burden is conceptualised as something distributed between patients and relational networks (May et al., 2014). While this is definitely an area which merits further exploration, this thesis was concerned with burden at the level of patient/carer networks, rather than the individuals within these networks.

Considering the strengths of the thesis as a whole, the problem of multimorbidity and treatment burden has been addressed from a range of perspectives using a coherent mixed methodology. A systematic review has established what is known so far about nurse-led interventions for people with multimorbidity, a cross-sectional study has established the burden of healthcare utilisation in this group from a service-level perspective, and the important perspective of patients and carers has been explored using a focussed ethnographic approach. The process has been supported throughout by patient and public advisers, who have been involved in developing patient-facing research materials, discussing findings, and reviewing research outputs. Intervention development also used an evidence based and theoretically-guided methodology (O’Cathain et al., 2019), which will be explained later in this chapter with reference to guidance provided by the Medical Research Council on the development of complex interventions (Skivington et al., 2021).

A possible limitation of the thesis is that for a large proportion of the research the focus was on general multimorbidity rather than people with multimorbidity and palliative conditions, the group for whom the intervention is intended. This was a conscious decision and not an oversight, the rationale for which can be explained in three stages. Firstly, it was identified at the outset that little was known about nurse-led interventions for people with multimorbidity, and that the evidence syntheses which had already been done were often based on comorbid conditions or groups of elderly/frail persons in whom multimorbidity was simply assumed. There was a significant knowledge gap, and it was believed to be more prudent to address multimorbidity from a generalist perspective, one which was concerned with the coexistence of any chronic conditions, rather than narrowing the focus to people with palliative conditions and multimorbidity. Secondly, the absence of multimorbidity (identified through disease-count) from many of the predictive models which helped to target multimorbidity interventions led to the enquiry of whether multimorbidity was a potentially useful variable in such models. This again required a broad generalist definition of multimorbidity. Focussing on palliative conditions at this juncture may have yielded significant relationships with inpatient mortality, but the utility of this information may have been less useful when targeting interventions at health care use. Finally, the focus moved towards people with multimorbidity and palliative conditions in the last stage of the thesis. It was believed that speaking to people who may have palliative conditions at this juncture was important, as there may be new perspectives on treatment burden which had not been explored at the patient level before.

8.4 Contextualisation of findings

The findings of the thesis will now be contextualised in relation to what is already known. The unique contributions made by the thesis will also be described in more detail.

8.4.1 How this thesis fits with what is already known

The effects of nurse-led interventions on outcomes were equivocal; they are acceptable to patients, they may improve domains such as health related quality of life, but they do not consistently reduce other important outcomes such as health care use, costs, or mortality. This is a common theme in both multimorbidity interventions and other nurse-led interventions which employ a case management or care coordination approach. In a Cochrane review of primary care multimorbidity interventions, there was little improvement in clinical outcomes, improvements in mental-health outcomes (from mostly comorbidity studies), probable small improvements in patient reported outcomes, medication adherence, patient-related health behaviours, healthcare provider behaviours (i.e., prescribing and quality of care), and no improvement in health care use. There was limited data on costs (Smith et al., 2021). In a systematic review of nurse-led case management interventions for older adults with multimorbidity (including studies which focussed mainly on advanced age or comorbid conditions), Lupari et al. (2011) found qualitative evidence to support the acceptability of interventions, but no significant quantitative improvements in health care use or costs. In a systematic review and meta-analysis of nurse led case management interventions for chronic conditions, there was a paucity of quantitative evidence of improvements in various outcomes, although pooled analyses showed reductions in blood pressure and diabetes biomarkers (Massimi et al., 2017).

The role of nurses in multimorbidity interventions are predominantly to coordinate care, for example as a case manager. However, lots of other intervention types exist which were not discussed in the thesis as they are not nurse-led. Self-management features in nurse-led interventions, but there are also many transdiagnostic self-management interventions which are often delivered by ‘lay-leaders’ or to frail elderly populations and therefore were not included in the review (Crowe et al., 2016). Polypharmacy interventions focussing on optimising prescribing and deprescribing potentially unnecessary medications also feature frequently, although these are generally pharmacist-led (Ali et al., 2022). Other types of interventions which are not nurse-led include training interventions for healthcare providers, ICT interventions (excluding those mentioned in the review), improving decision making (e.g., through decision support tools), or enhancing interdisciplinary team work (Poitras et al., 2018). Nurse-led interventions for people with multimorbidity were the focus of this thesis, but it is important to remember that these are only one part of the landscape, and that innovation is taking place in other specialties and alongside interdisciplinary efforts.

The association between multimorbidity and healthcare use was also reinforced in this thesis. A systematic review of UK studies linked multimorbidity (identified using a wide variety of definitions and in a range of populations) with increased primary care use, hospitalisation, ED attendance, dental visits, and increased costs in relation to care transitions, hospitalisation and primary care (Soley-Bori et al., 2021). No association was detected in this thesis between multimorbidity and inpatient mortality, although crude comparison shows people with multimorbidity having much higher mortality at different timepoints, compared to people with fewer than two conditions. The association between multimorbidity and mortality is well-established (Siah et al., 2022; Willadsen et al., 2018), and in this thesis some association was noticed at specific disease-counts (1-3 conditions). A possible explanation for the lack of a significant association comprises two factors; firstly, the relatively low counts of people who died while admitted who had four or more conditions, and secondly, the effects of individual conditions with associated high-risk of mortality (such as cancer) outweighing the effects of multimorbidity and complex multimorbidity.

The focussed ethnographic study provided further evidence of the role treatment burden plays in the way people with multimorbidity and those who care for them interact with healthcare services. Burden of Treatment Theory (May et al., 2014) holds explanatory power in this patient group, providing a framework through which the balance between workload and capacity can be explored. The burdensome tasks which were described by patients and carers were a combination of simple practical tasks like going to hospital, taking medicines and doing exercise, and more high-level planning and surveillance responsibilities. Balancing treatment burden is a social act, mediated through the strength of relational networks, access to information and resources, and the characteristics of healthcare provision which is available. Similar tasks have been described in other populations including people with multimorbidity (from a limited number of conditions) in Malawi (Chikumbu et al., 2022), in people with cancer (Adam et al., 2023), and people who have experienced stroke (Gallacher et al., 2013).

The psychological and emotional burden experienced by participants was characterised through the lens of total uncertainty. Etkind et al. (2022)'s description of total uncertainty was based on a systematic review of qualitative studies involving people aged 65 or older with advanced multimorbidity (including life-limiting conditions), and the physical, practical, psychological and social dimensions of uncertainty mapped on to the experiences of the participants in this thesis. Uncertainty in healthcare has been explored through various lenses, such as waiting for health-related news (Sweeny and Cavanaugh, 2012), or uncertainty around recovery in people nearing the end of life (Koffman et al., 2019). It is not a unique feature of multimorbidity, but Etkind et al. (2022)'s description is useful in that it encapsulates the multidimensional nature of uncertainty. Similarly, Hillen et al. (2017)'s conceptual model of uncertainty tolerance is useful in understanding the dynamic nature of uncertainty, and how intolerable uncertainty can manifest negative outcomes.

There are also thematic similarities with other qualitative studies involving people with chronic conditions. In describing some of the factors that exacerbate how patients experience treatment burden, Eton et al. (2015) describe 'interpersonal factors' or 'healthcare provider challenges', concepts which have similarities with social uncertainty and fragmented care (Etkind et al., 2022). Even the concept of living with uncertainty has been discussed in relation to treatment burden in several qualitative studies previously (Demain et al., 2015); however, the multidimensional nature of the uncertainty stimulus has not been explored in people with multimorbidity as has been done in this thesis.

Other research has managed to develop new theoretical constructs from Burden of Treatment Theory. In a recent study involving people with HIV and comorbidities in South Africa, van Pinxteren et al. (2023) applied the lens of Burden of Treatment Theory and the Cumulative Complexity Model (Shippee et al., 2012) to discuss the concept of persistent precarity. The dimensions of precarity in their study are contextually grounded, and it may not have the transferability of the concept of uncertainty, but it provides further evidence of the utility of Burden of Treatment Theory as an analytical lens.

The focussed ethnographic study also emphasised the value of engagement with a continuous healthcare professional. This is not novel, as the association between good relationships with healthcare providers and feeling less burdened by treatment has been highlighted before (Eton et al., 2017); however it is useful to establish this phenomena is also present in the population under investigation. Often the steps which could have been taken to reduce burden and uncertainty were relatively straightforward, such as better sharing of information of coordination between services. Interestingly, similar themes were highlighted by Tran et al. (2019) in a qualitative study of people living with HIV in sub-Saharan Africa, suggesting a degree of universality around what patients expect from their healthcare provider.

8.4.2 Where this thesis makes a unique contribution to the field

As touched on in the preceding section, the unique contributions of this thesis include identifying what the role of the nurse is in caring for people with multimorbidity, and that role centres around helping patients and carers navigate complex treatment regimens and healthcare services. This is not to discount the importance of behavioural change self-management interventions, or polypharmacy interventions, but based on the evidence these are interventions which may be better led by other members of the interdisciplinary team, such as pharmacists or people trained in counselling (Ali et al., 2022; Crowe et al., 2016).

The need for care coordination was reinforced during the qualitative phase, in which several participants identified nurses in cancer care or primary care with whom they had an ongoing relationship, and to whom patients felt they could go to resolve problems with accessing care or making sense of treatments. This was not necessarily part of the prescribed role of these nurses, but rather an example of where an ongoing therapeutic relationship with a specified individual created a safe environment, in which the nurse was seen as a relational network member through whom access to informational and material resources flow (May et al., 2014). This thesis has sought to avoid focussing on specific conditions, but the frequency with which cancer care was referenced is worth attention. Cancer nursing in the UK is relatively well-developed with a large number of nurses in different types of advanced clinical roles (Kelly et al., 2020), however it is the continuity of care and the trusting relationship which appears to be most appreciated by the participants in this thesis.

This is particularly important given the social dimension of uncertainty which was prevalent. Due to a range of factors including negative care experiences, treatment burden, and simply feeling overwhelmed by uncertainty, some people with multimorbidity and their carers developed feelings of mistrust and uncertainty about interacting with services, and this in turn led to further conflict, which intensifies social uncertainty in a feedback loop which ultimately results in disengagement, missed opportunities, and worsening outcomes. Against this backdrop, it is hard to underestimate the value of a trusted individual who is seen to be on the patients' side, helping them navigate complexity and achieve their goals. What nurses do is poorly understood by the general public (Hoeve et al., 2014), but the profession largely enjoys a trusted position in public perceptions (Girvin et al., 2016); it would be prudent then to use this trusted position to help patients and carers navigate the complex landscape of chronic illness care.

In arguing for a generalist professional who has an ongoing relationship with the patient and who helps them access and navigate services, it may seem like what is being proposed is simply better access to primary care. This would be a mischaracterisation of what is being proposed, but there is undoubtedly overlap between the way nurses should care for people with multimorbidity and the primary care approach. A proposed model for primary care consultations in the context of multimorbidity, the Ariadne principles (named after the princess from Greek mythology who guided Theseus from the Minotaur's labyrinth), also provide a framework which may be useful for nurse-led case management or care coordination. The principles are centred around realistic treatment goals, and emphasise individualised management and prioritisation of patient preferences, with a continued awareness and assessment of the myriad factors which interact with one another in multimorbidity, including conditions, symptoms, drugs, biographical disruptions, and contextual changes (Muth et al., 2014). Goal-setting is a strong example of where primary care practices may be of value. In an analysis of video-recorded patient/GP interactions in the UK, the importance of both the patient and the GP being engaged and prepared, of not only eliciting but legitimising goals, and of the need for collaborative goal setting was described (Salter et al., 2019).

This is not to say that the natural home of a nurse-led intervention is necessarily in primary care, but given the challenges faced by primary care services (which were only worsened by the COVID-19 pandemic) (Khalil-Khan and Khan, 2023), the ability for a nurse-led intervention to support the work done by GPs, nurses and other professionals working in primary care could be useful.

The question of when to intervene and with whom also merits attention. This thesis is (to the author's knowledge) the first to explore the prevalence of multimorbidity and its effect on outcomes in a large population of urban ED attenders. The strong association between healthcare use provides justification for intervening in order to limit additional unplanned and unnecessary reattendances and admissions, but there are caveats. Firstly, patterns of intensive healthcare use tend to regress to the mean, so that by the time someone has begun a period of intensive healthcare use, it may already be too late to influence outcomes in any meaningful way (Shilpa Ross et al., 2011); there is a high turnover in high-intensity healthcare users, and those who consume a large volume of services in one year may not do so the following year (Kyle et al., 2021). Secondly, people with multimorbidity comprised around 20% of the population, which is likely too large a cohort to target in a way that will generate significant improvements. Complex multimorbidity was not necessarily a more useful indicator of future healthcare use either.

Setting the threshold at a higher number of conditions may be useful, as in most analyses the relationship between the number of conditions and negative outcomes was broadly linear, increasing with the number of conditions a person has. The purpose of the cross-sectional phase of this thesis was simply to assess the significance of the exposures, in order to establish whether they may be useful variables to consider when testing and training models to predict negative outcomes, and these aims were achieved. Another avenue which may merit attention, however, is the utility of multimorbidity or disease thresholds in clinician-administered risk stratification. Given that the conditions were detected using algorithms validated with moderate to high accuracy in a large cohort of patients (Tonelli et al., 2016), it is possible that the detected conditions may correspond to what can be elicited during a consultation or clinical history-taking. Further validation would be required in this population, but recent developments such as the ISARIC-4C risk score (Knight et al., 2022) used during the COVID-19 pandemic demonstrate the usefulness of such tools in risk stratification at the front door of the hospital.

Another area in which this thesis makes a unique contribution to the field of multimorbidity research, is in the production of a theoretically-grounded conceptual model of the way uncertainty impacts on the balance between capacity and workload in the context of treatment burden. As discussed in the preceding section, the concepts of total uncertainty (Etkind et al., 2022), uncertainty tolerance (Hillen et al., 2017), and treatment burden (May et al., 2014) are well-established in the literature; however, this thesis is the first to describe how these models intersect in a way that can impact on engagement with healthcare services and satisfaction with care. Further exploration of this model in other studies is warranted given that this is a micro-range theory developed in a small population, but its explanatory power in the focussed ethnographic study was instrumental in understanding cases where imbalances between capacity and workload were not sufficiently explained by Burden of Treatment Theory alone. The interpersonal dynamic characterised by social uncertainty is particularly interesting, and while some dimensions of Burden of Treatment Theory account for this (such as social skill or cognitive participation), the concept of social uncertainty outlined by Etkind et al. (2022) aligns more closely with what was observed in this thesis. Hillen et al. (2017)'s integrative model of uncertainty tolerance introduces a dynamic element to how uncertainty affects actions, allowing for the integration of Etkind et al. (2022)'s taxonomy with the dynamic processes of Burden of Treatment Theory.

The final way in which this thesis makes a unique contribution to the field is arguably the most significant and is covered in greater detail in the next section. This thesis presents a theory-based conceptual model of a nurse-led intervention for people with multimorbidity and palliative conditions. The development process has been theoretically-grounded and is transdiagnostic in the sense that it does not assume the presence of specific conditions, only that the person with multimorbidity can benefit from individualised care in order to help them manage burdensome treatment. The intervention has been designed for people with multimorbidity and palliative conditions, however, given the disease-agnostic approach taken, it could be argued that the intervention may be of value to people with multimorbidity more generally. There is a need to extend the scope of who is included in any evaluation of the intervention beyond only people with palliative conditions.

8.4.3 How this applies to the local context

In the opening chapter of the thesis, the local context in which the research was conducted was described. This was not intended to limit the relevance of the research, but rather to position it in context so that the findings could be understood better. It is envisioned that the intervention which will be described in the following section will be of value beyond Glasgow, yet it is also important to reflect on some of the findings and how they may have local relevance.

In the cross-sectional study, greater levels of some conditions (particularly alcohol misuse) were noted, and while this may partly be due to the cohort being ED attenders rather than a primary care or community population, there are also potentially environmental and social factors shaping these patterns. Scottish data has shown that multimorbidity onset occurs ten years earlier in the most deprived areas than the most affluent (Barnett et al., 2012), and the significant majority of the study population were in the lowest two SIMD deciles (Figure 6-2, page 156). Arguably, environment plays a role in this disparity; in a relatively recent spatial cluster analysis of Glasgow, it was noted that alcohol, tobacco, fast-food and gambling outlets were significantly more prevalent in low-income areas, and that there was a significantly increased likelihood of several of these outlets being clustered together in low-income areas (Macdonald et al., 2018). Individual agency is not the sole determinant of whether someone makes healthy choices, and the geography of some areas in Glasgow can make this all but impossible.

In the focussed ethnographic study, there was a concerted effort to recruit people who lived in different parts of the city. This is important, not simply for the potential variations in health status (all participants had multimorbidity), but because the distribution of care is similarly varied between the most affluent and least affluent areas. The ‘inverse care law’ describes how those with the most resources and the least need have better access to care, while those who are under-resourced and have the greatest need have poorer access (Tudor Hart, 1971). While this effect may be at its strongest when provision of healthcare is exposed to free market forces, there are also non-financial drivers of inequity, including the likelihood that people with better resources may be more likely to seek out care, or may be more able to travel to health care services (Cookson et al., 2021). Efforts have been made in primary care to redress this imbalance through the establishment of ‘Deep End’ GP networks (the first of which was introduced in Scotland in 2009 (Mercer et al., 2021)), yet the problems persist.

There is a social argument then, for interventions such as that which will be described in the next section, particularly in a context such as Glasgow. However, the aim of such an intervention is not solely to remedy a ‘Glasgow effect’ or ‘Scotland effect’ (McCartney et al., 2011; Reid, 2011); as has been discussed, the destabilising effects of treatment burden and uncertainty may be mediated by material resources, but they cannot be insulated against completely.

8.5 Model for a nurse-led intervention for people with multimorbidity and palliative conditions

In this final section of the chapter, a model for a nurse-led intervention for people with multimorbidity and palliative conditions is outlined. The process through which the intervention was developed has already been explained; however, to demonstrate rigour it will also be mapped to the recommendations outlined by the MRC guidance for the development of complex interventions (Skivington et al., 2021).

8.5.1 Mapping the thesis to the MRC Guidelines

The recent update of the MRC guidelines makes the distinctions between four perspectives from which an intervention can be developed: efficacy (does it work in experimental settings?), effectiveness (does it work in real settings?), systems (how do the system and the intervention fit together?), and theory-based (What works in which circumstances and how?) (Skivington et al., 2021). The approach taken in this thesis is theory-based, seeking to understand the various components of the intervention and why some work better than others. At all stages of the process, the MRC guidance recommends considering six core elements: context, programme theory, stakeholder engagement, identifying uncertainties, refining the intervention, and economic consideration. This section provides a brief summary of how these elements have been considered in the thesis. This is done not only in the interest of showing what has been achieved so far, but also in to highlight areas where work still remains.

8.5.1.1 Context

The context in which the intervention is situated was considered during the systematic review and in the focussed ethnographic study. A large number of nurse-led interventions were situated in primary care, however, if the intervention is to be delivered at health-board level and potentially making use of secondary care data, a more centralised location may also be suitable. The physical setting of a hospital has some benefits in the local context of Glasgow: participants in the focussed ethnographic study had frequent issues with emergency travel, but several noted that the city's hospitals were better served with public transport and if organised in advance, patient transport was useful in getting people to outpatient clinics. Some also noted that access to other specialties, imaging and investigations would be a benefit.

This all assumes a physical context, however, there is also the matter of remote consultations which have become particularly relevant in the aftermath of the COVID-19 pandemic. Implementation of such services present multidimensional challenges which must be addressed if they are to be normalised (Greenhalgh et al., 2021), and there were mixed views on how suitable these were during the focussed ethnographic study, particularly when any sort of physical examination was necessary. Yet the proposed intervention focusses on coordination and management of care rather than clinical intervention, and for many participants there was a convenience element to telephone calls which was desirable. It may be suitable then to have an intervention physically located within a central location (i.e., a hospital), with the capacity to both see patients face-to-face, but also to conduct a large volume of interactions using telephone and video calls.

It is also worth reiterating the social factors which affect Glasgow and how these are relevant to the intervention. As discussed earlier in the chapter, there are significant differences in both health status and access to healthcare throughout the city, with the most deprived areas having poorer health and less access to care. While the intervention does not explicitly target such inequality, by focussing on mobilising the capacity of individuals and their relational networks in a contextually-situated way, providing tailored guidance and continuity, the intervention is well-placed to support those who are living with a complex mix of physical, mental and social care needs.

8.5.1.2 Programme theory

The application of theory has been important throughout the thesis, and this remains the case in the proposed intervention. The overarching theories which will guide the intervention are Burden of Treatment Theory (May et al., 2014) and the conceptual model of uncertainty and burden which was developed during the focussed ethnographic phase of the thesis. These models provide a framework against which patients can be assessed, shared goals can be set, care can be planned, and support from the community and the wider multidisciplinary team (MDT) can be secured. The consultation model proposed in the Ariadne principles provides a useful structure for consultations (Muth et al., 2014). The model of nursing care is at its core a primary nursing approach (Pearson, 1988), as continuity of care was seen as important by almost everyone in the focussed ethnographic study.

There are validated tools which can be used to assess treatment burden (Tran et al., 2014; Tran et al., 2012) and some specifically developed for people with multimorbidity (Duncan et al., 2018), but the absence of such a tool to assess the multidimensional uncertainties faced by people with multimorbidity is a gap which must be addressed. Given that uncertainty comprises a key element of the underlying programme theory, the development of either a validated measure or a co-created patient-owned document (similar to myACP (Healthcare Improvement Scotland, 2023)) should be a priority.

8.5.1.3 Stakeholder engagement

Stakeholder engagement in the form of patient and public involvement has been ongoing throughout the thesis, informing the methods of the research and improving the accessibility of materials. This approach is embedded in the practices of the research group to which the thesis author belongs; a summary of these activities is provided in a manuscript which has been accepted for publication (Appendix 15). Owing to the fact that the intervention has been developed as a result of the research phases described in the thesis, it has not been discussed in its current form with patient and public stakeholders; this will be essential before any piloting or further development can take place. Another group who have not been consulted are the clinical staff (nurses, doctors and allied health professionals) who may come into contact with the intervention. In the next phase of development, it will also be essential to involve clinical stakeholders.

8.5.1.4 Identifying key uncertainties

The identification of key uncertainties in relation to the intervention is an essential step in development (Skivington et al., 2021). The model proposed here is conceptual and before it is piloted there are still several questions to be answered, including:

- At what level of sensitivity should the predictive model for identification operate?
- What level of training does the nurse delivering the intervention require (ANP/CNS/other)?
- What should the distribution between face-to-face and remote contact be between nurses and patients?
- How should uncertainty be assessed in the context of multimorbidity (validated tool/co-created document)?

Some of these uncertainties are reflected in the recommendations in the next chapter. Another domain in which uncertainty exists is the economic effect of such an intervention, which will be discussed later.

8.5.1.5 Refining the intervention

Refinement of the intervention should take place not only between each phase of development, but during each phase to reflect new knowledge or changes to programme theory. In the interest of demonstrating this process, Figure 8-1 provides an overview of what the intervention model comprised after the completion of the systematic review, while the cross-sectional study was ongoing and before the focussed ethnographic study.

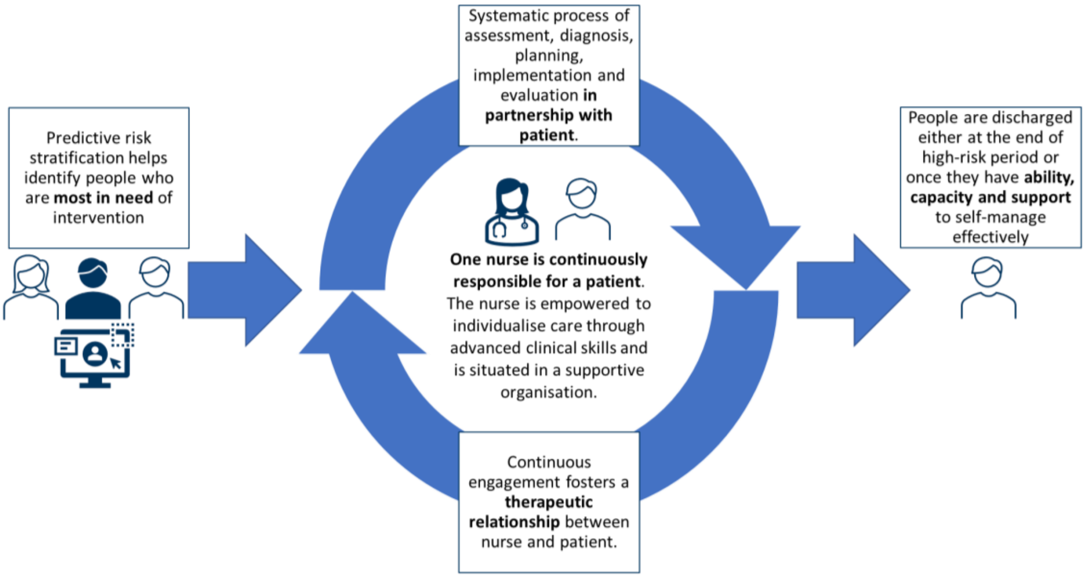


Figure 8-1: Early iteration of model developed after completion of the systematic review.

Notable absences from this model include any mention of uncertainty and a lack of clarity over patient identification. Referring back to Table 8-1, these elements were only identified in the second and third phases of the research. The process of refinement is ongoing, and the model which is presented later in the chapter is just the latest iteration of this process.

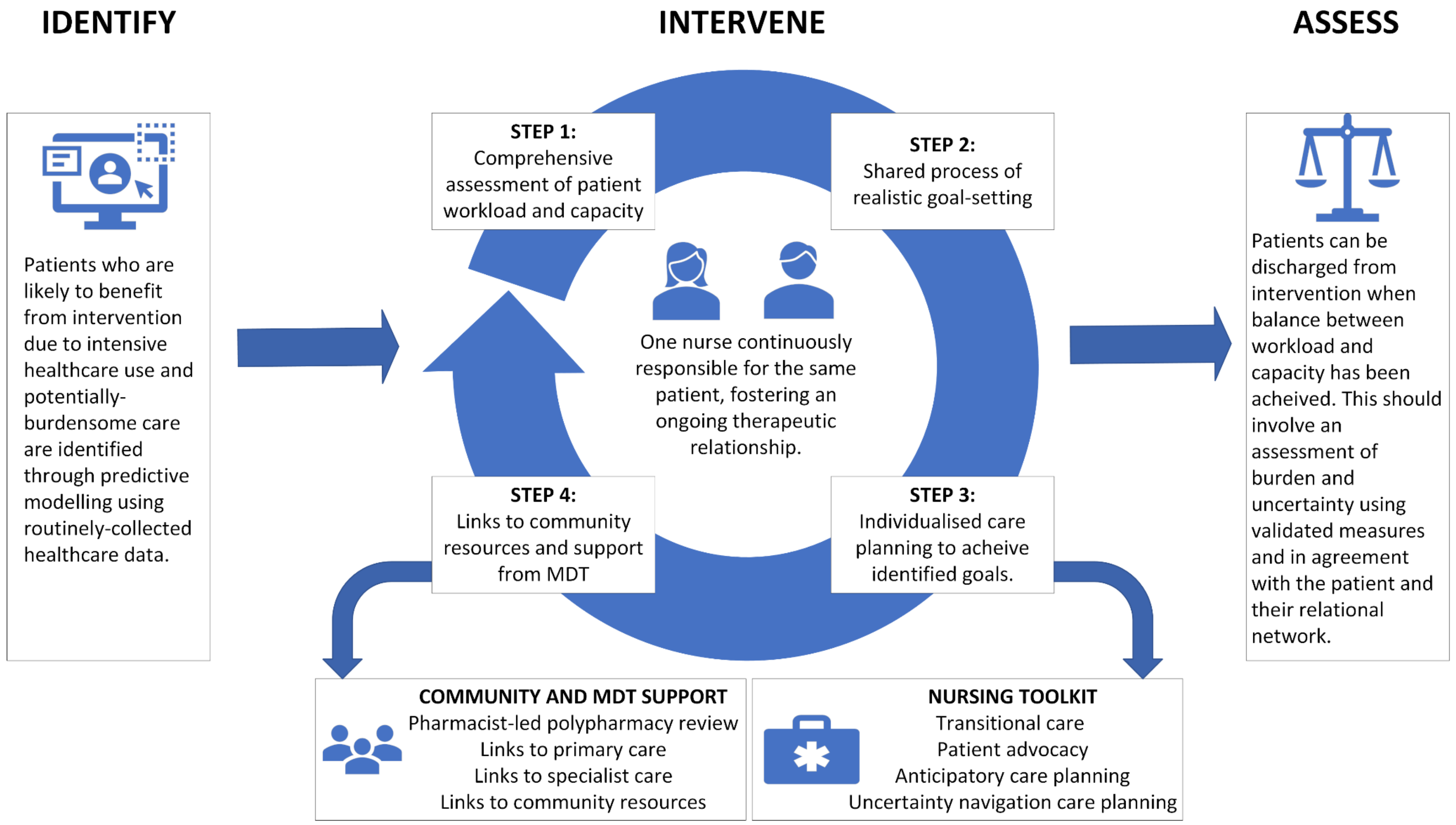
8.5.1.6 Economic considerations

Finally, the economic effect of the proposed intervention has not been discussed in this thesis. There is a definite need to achieve at least cost-neutrality alongside an improvement in outcomes, but conducting an economic analysis was beyond the scope of this thesis. As noted during the systematic review, nurse-led interventions for people with multimorbidity have often failed to demonstrate economic viability, so expertise in health economics must be sought at an early point in the next stage of development.

This is particularly important given that the intervention does not simply propose substituting medical care for nursing care; instead it recommends the addition of further nursing care. In theory, it is hoped that by optimising care and reducing burdensome activity that patient capacity to self-manage will improve and unscheduled care use may reduce. However, this is a purely theoretical assumption and will require investigation as part of any evaluation of the intervention.

8.5.2 A proposed model of a nurse-led intervention for people with multimorbidity

Finally in this section, the proposed model for a nurse-led intervention for people with multimorbidity and palliative conditions is presented. Figure 8-2 provides an outline of the proposed intervention.



IDENTIFY

Patients who are likely to benefit from intervention due to intensive healthcare use and potentially-burdensome care are identified through predictive modelling using routinely-collected healthcare data.

INTERVENE

STEP 1:
Comprehensive assessment of patient workload and capacity

STEP 2:
Shared process of realistic goal-setting

One nurse continuously responsible for the same patient, fostering an ongoing therapeutic relationship.

STEP 3:
Individualised care planning to acheive identified goals.

STEP 4:
Links to community resources and support from MDT

COMMUNITY AND MDT SUPPORT
Pharmacist-led polypharmacy review
Links to primary care
Links to specialist care
Links to community resources

NURSING TOOLKIT
Transitional care
Patient advocacy
Anticipatory care planning
Uncertainty navigation care planning

ASSESS

Patients can be discharged from intervention when balance between workload and capacity has been acheived. This should involve an assessment of burden and uncertainty using validated measures and in agreement with the patient and their relational network.

Figure 8-2: Conceptual model of a nurse-led intervention for people with multimorbidity and palliative conditions.

The first component of the intervention is the identification of individuals who are at risk of intensive healthcare utilisation and potentially burdensome treatment. Based on the cross-sectional study, there is justification for building multimorbidity into predictive models, but if targeting ED admission and reattendance it may be more appropriate to set the threshold at a higher level than two conditions. As noted earlier, the exact threshold along with the other variables required remain to be determined.

The intervention itself is based around a primary nursing case management model, in which the aim is to coordinate and plan individualised care in a way which does not overburden the patient. Comprehensive assessment and goal setting are an important phase, and this should include assessment of treatment burden and sources of uncertainty. In planning care, the nurse should have a range of tools at their disposal, including the ability to intensify transitional care before and after hospital discharge (when applicable), to act as an advocate for the patient when dealing with other areas of the healthcare system, and tools for the assessment of treatment burden and uncertainty (the latter of which will be developed specifically for this purpose). Integration with primary care, various specialties, and the wider MDT (including the potential to trigger a pharmacist-led polypharmacy review) are also important elements.

The assessment, goal setting, care planning and resource-linkage process should be iterative, with patients only considered for discharge from the service once they have achieved an acceptable balance between workload and capacity, and once uncertainty is at an acceptable level. Assessment of this should be undertaken in partnership with important members of the relational network (such as family members) alongside the use of validated (and potentially bespoke) measures.

8.6 Chapter summary

This chapter has contextualised the findings of this thesis with reference to the published literature, identifying both strengths and weaknesses. The development process of a nurse-led intervention for people with multimorbidity and palliative conditions has been described with reference to a theory-based methodology of intervention development. Finally, the intervention which has been developed throughout the thesis has been presented. In the next and final chapter, some recommendations for research, policy and clinical practice are outlined, before the conclusion of the thesis.

Chapter 9. Conclusion and recommendations

9.1 Introduction

This aim of this thesis has been to develop a model of nurse-led intervention for people with multimorbidity and palliative conditions. In this final chapter, a summary of how this has been achieved will be provided alongside some recommendations for researchers, policymakers, and clinical colleagues. Finally, the thesis concludes with some comments on the future of multimorbidity and nursing research.

9.2 Summary of the thesis

This thesis opened by highlighting the global prevalence and impact of chronic disease and multimorbidity. At a societal level this means excess mortality (Bennett et al., 2020), lost productivity (Schofield et al., 2016), and excessive healthcare consumption (Abegunde et al., 2007; Waters and Graf, 2018). At an individual level, multimorbidity often results in burdensome, fragmented and inefficient care (Boyd et al., 2014; May et al., 2014; Shippee et al., 2012).

Applying a multimorbidity lens to the problem of chronic disease requires the characterisation of conditions as overlapping phenomena which must be considered within the individual (Boyd and Fortin, 2010). It is just one of many analytical and classificatory lenses applied to disease and illness from antiquity to the present day (Feinstein, 1970; Foucault, 1973; Jakob, 2017). Perspectives on nursing have similarly shifted throughout its history (Hatchett, 2003; Mackey and Bassendowski, 2017), yet the person-centred approach of therapeutic, primary nursing (McMahon, 1991; Pearson, 1988) may be particularly suited to improve the way care is provided to people living with multimorbidity in its innumerable permutations. The volume of multimorbidity research has grown significantly in recent years (Ahmed et al., 2020), yet relatively little is known about the role of nursing in the age of multimorbidity (O'Connor et al., 2018).

This thesis aimed to develop a theory-based nurse-led intervention to improve care for people with multimorbidity and palliative conditions, with a mixed methods approach comprising a systematic literature review of nurse-led multimorbidity interventions, a cross-sectional study of ED attenders, and a focussed ethnographic study involving people with multimorbidity and those who care for them.

The review found that most interventions were focussed on coordination of care, in the form of either short targeted transitional care interventions, or longer-term case management interventions. While these were agreeable to patients and had positive effects on patient centred outcomes, there was less robust evidence of improvements in reducing health care use or costs.

The cross-sectional study found significant associations between multimorbidity, complex multimorbidity, and health care use. The more conditions a person has, the stronger the association is. No such association was noted between these variables and inpatient mortality, despite people with multimorbidity and complex multimorbidity having a greater risk of mortality at a range of other time-points.

The focussed ethnographic study found that treatment burden was a multidimensional phenomenon, distributed between patients and carers, and this workload was balanced with the capacity of patients and relational network members. This reflects the description of burden provided by Burden of Treatment Theory (May et al., 2014). The additional burden of uncertainty was also found to interact with the balance between capacity and workload. A conceptual model of this relationship was developed.

Using these findings, a theory-based model of a nurse-led intervention for people with multimorbidity and palliative conditions was developed. The model is grounded by Burden of Treatment Theory, a primary nursing care coordination approach, and the conceptual model of uncertainty and burden developed in the thesis. It requires that the right patients are identified using predictive modelling, and that one continuous nurse provides individualised assessment, goal-setting, and care planning to ensure that workload and capacity are balanced, and that sources of uncertainty are addressed. The nurse has a range of tools at their disposal to facilitate this process and should be able to link to resources in the community and through the multidisciplinary team. Discharge from the intervention should involve a holistic assessment of treatment burden and uncertainty which factors in not only the patient but their relational network.

The model proposed by the thesis is theoretical, and will require further refinement, including an economic assessment and an ongoing process of stakeholder involvement.

9.3 Recommendations

Alongside the developed intervention, several recommendations can be made resulting from the findings of the thesis. These relate to other researchers in the field, to policy makers responsible for nursing and health care, and to clinical colleagues who may come into contact with the large proportion of society who are living with multiple chronic conditions.

9.3.1 Research recommendations

- The micro-range theory of the relationship between treatment burden and uncertainty requires further development and/or validation. The model holds good explanatory power in the study described in the thesis, but applying the theory as an analytical framework in other qualitative studies will help to establish its wider utility.

- More theoretical work to develop specific models of nursing practice for people with multimorbidity is required. Primary ethnographic research with nurses who care for people with multimorbidity (for example in primary care, emergency care, or care of the elderly) may be a useful starting point.

- Multimorbidity, complex multimorbidity and disease thresholds should be further explored for their usefulness as coefficients in predictive models when targeting interventions for people with multimorbidity. The use of validated disease-identification algorithms can help make such models more explainable to clinicians and patients.

- Alternative methods of assessing the effectiveness of multimorbidity interventions should be considered. An RCT may fail to capture many of the ways in which such interventions can improve care for patients.

- Economic evaluation of multimorbidity interventions is essential if such interventions are to be adopted in practice. Future research should incorporate such evaluation into the design of studies.

- Significant variation remains in how multimorbidity is presented in the literature; researchers should fully explain how multimorbidity is identified in studies, ideally using a reproducible methodology.

9.3.2 Policy recommendations

- Given the ubiquity of multimorbidity and the likelihood that it will only increase in the future, pre-registration nursing education should prepare the next generation of nurses by exploring concepts such as treatment burden and the differences between multimorbidity and comorbidity frameworks of assessment and care planning.

- Innovation in the way nursing care is delivered to people with multimorbidity should be encouraged; funding should be made available to explore which nursing roles (ANPs, CNS, other) are best suited to provide continuous care for this group.

- Structural reform in the way care is delivered may be necessary in order to ensure burdensome and inefficient care does not proliferate as patients become more complex. Better integration between secondary and primary care should be a priority.

9.3.3 Clinical recommendations

- A perspective shift is required from single disease and comorbidity frameworks to a multimorbidity framework. This involves viewing conditions as multiple and overlapping and recognises that precedence of specific conditions should not be assumed by the clinician.

- Changes to care should involve consideration of how they may affect the balance between a patient's workload and their capacity to undertake the work. This assessment should also consider how the relational network are involved in supporting the patient, and what steps can be taken to ensure cognitive and practical resources are not overwhelmed.

- Sources of uncertainty should be identified and resolved where possible. Existential concerns (such as those related to prognosis or disease-course) may not be resolvable; in these cases clinical personnel should acknowledge them and work towards understanding and acceptance of uncertainty.

9.4 Concluding remarks

Nothing material changes in the patient when a nurse views them through the lens of multimorbidity. The change is entirely in the observer, who is required to adopt a different position from which to view the same patient, the same chronic conditions, the same social context. But this change provides a vantage point from which further change can be affected. From this perspective, the patient can be understood as an agent interacting with a system, leveraging social and material resources in order to cope with an increasingly burdensome list of demands. Add to this a multidimensional uncertainty which manages to undermine capacity while magnifying the perceived workload, and it becomes evident that the problem lies not with the agent, but with the system.

This thesis does not argue for radical change. Specialism exists because it is needed; the vast advances in cancer care over recent decades would not have been possible if the individual oncologist was also required to hold equivalent knowledge of orthopaedics, tropical medicine, and forensic psychiatry. At the same time, generalism persists because there will always be a need for broad and person-centred expertise in the management of people throughout their life course. Diseases will always require management, be that curative or palliative.

Where change is needed is in helping people with multiple conditions to cope with the complexity which is a necessary by-product of the way healthcare is provided in the 21st century. It is here that a gap exists, which should be filled by individuals with expertise in navigating complex systems, and in planning care which balances the demands of treatment with the individual’s ability to do the prescribed work. It is in this gap that nursing may have a role to play in changing how care is provided to the growing number of complex patients who are struggling in a system ill-suited to their needs.

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Appendix 1

RECORD Checklist for cross-sectional study

	Item No.	STROBE items	Location in manuscript where items are reported	RECORD items	Location in manuscript where items are reported
Title and abstract					
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	Page ii	RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. RECORD 1.2: If applicable, the geographic region and timeframe within which the study took place should be reported in the title or abstract. RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	Page ii
Introduction					
Background rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 69		
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 7		
Methods					
Study Design	4	Present key elements of study design early in the paper	Page 95		
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 95-96		
Participants	6	*(a) Cohort study* - Give the eligibility criteria, and the sources and methods of selection of		RECORD 6.1: The methods of study population selection (such as codes or algorithms used to identify subjects) should be listed in detail. If this is not	4.5.7.2 Exposure variables (page 101)

		participants. Describe methods of follow-up *Case-control study* - Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study* - Give the eligibility criteria, and the sources and methods of selection of participants *(b) Cohort study* - For matched studies, give matching criteria and number of exposed and unexposed *Case-control study* - For matched studies, give matching criteria and the number of controls per case	Page 100	possible, an explanation should be provided. RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided. RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.	Appendix 7 (page 314) 4.5.7.2 Exposure variables (page 101) Appendix 7 (page 314) Figure 6-1 (page 155)
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.	4.5.7 Variables (page 100)	RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	Appendix 7 (page 314)
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Appendix 7 (page 314)		
Bias	9	Describe any efforts to address potential sources of bias	4.5.10 Missing data (page 109)		
Study size	10	Explain how the study size was arrived at	Figure 6-1 (page 155)		
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	4.5.9 Data linkage and data cleaning (page 108)		

Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) *Cohort study* - If applicable, explain how loss to follow-up was addressed *Case-control study* - If applicable, explain how matching of cases and controls was addressed *Cross-sectional study* - If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses	4.5.8 Statistical methods (from page 105) 4.5.8 Statistical methods (from page 105) 4.5.10 Missing data (page 109) N/A 4.5.10 Missing data (page 109)		
Data access and cleaning methods		..		RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population. RECORD 12.2: Authors should provide information on the data cleaning methods used in the study.	4.5.9 Data linkage and data cleaning (page 108) 4.5.9 Data linkage and data cleaning (page 108
Linkage		..		RECORD 12.3: State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	4.5.9 Data linkage and data cleaning (page 108
Results					
Participants	13	(a) Report the numbers of individuals at each stage of the study (*e.g.*, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed) (b) Give reasons for non-participation at each stage.	Figure 6-1 (page 155) Figure 6-1 (page 155)	RECORD 13.1: Describe in detail the selection of the persons included in the study (*i.e.*, study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	Figure 6-1 (page 155)

		(c) Consider use of a flow diagram	Figure 6-1 (page 155)		
Descriptive data	14	(a) Give characteristics of study participants (*e.g.*, demographic, clinical, social) and information on exposures and potential confounders	Table 6-1 (page 157)		
		(b) Indicate the number of participants with missing data for each variable of interest	6.4 Comparison with post-imputation analyses (page 163)		
		(c) *Cohort study* - summarise follow-up time (*e.g.*, average and total amount)	N/A		
Outcome data	15	*Cohort study* - Report numbers of outcome events or summary measures over time	N/A		
		Case-control study - Report numbers in each exposure category, or summary measures of exposure	N/A		
		Cross-sectional study - Report numbers of outcome events or summary measures	Table 6-1 (page 157)		
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included	6.3 (page 159 onwards), Appendix 13 (page 362) Appendix 14 (page 374)		
		(b) Report category boundaries when continuous variables were categorized	N/A		
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A		
Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	Table 6-3 (page 166)		
Discussion					
Key results	18	Summarise key results with reference to study objectives	8.2.2 Phase 2: Cross-sectional study of ED attenders (page 234)		

Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	8.3 Strengths and limitations (page 238)	RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	8.3 Strengths and limitations (page 238)
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8.4 Contextualisation of findings (page 242)		
Generalisability	21	Discuss the generalisability (external validity) of the study results	8.4 Contextualisation of findings (page 242)		
Other Information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Funding statement (page xii)		
Accessibility of protocol, raw data, and programming code		..		RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	Appendix 6

*Reference: Benchimol EI, Smeeth L, Guttmann A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langan SM, the RECORD Working Committee. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Medicine* 2015; in press.

Appendix 2

PRISMA Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	4.4 (p 81)
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	N/A
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	4.4 (p 81)
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	4.4 (p 81)
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	4.4.4 (p 87)
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	4.4.5 (p 89)
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Appendix 3 (p275)
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	4.4.5 (p 89)
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	4.4.5 (p 89)
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	4.4.7 (p 92)
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	4.4.7 (p 92)
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	4.4.6 (p 90)
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	4.4.7 (p 92)
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	4.4.8 (p 93)
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data	4.4.8 (p 93)

Section and Topic	Item #	Checklist item	Location where item is reported
		conversions.	
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Appendix 11(p 329)
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	4.4.8 (p 93)
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	NA
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	4.4.6 (p 90)
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	4.4.6 (p 90)
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	NA
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Figure 5-1 (p 127) Figure 5-2 (p 128)
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	NA
Study characteristics	17	Cite each included study and present its characteristics.	Appendix 11(p 329)
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Appendix 12 (p 358)
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Appendix 11(p 329)
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Appendix 11(p 329) Appendix 12 (p 358)
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	NA
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	NA
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	NA
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	NA
Certainty of	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	NA

Section and Topic	Item #	Checklist item	Location where item is reported
evidence			
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	8.2.1 (p 233)
	23b	Discuss any limitations of the evidence included in the review.	8.3 (p 238)
	23c	Discuss any limitations of the review processes used.	8.3 (p 238)
	23d	Discuss implications of the results for practice, policy, and future research.	9.3 (p 262)
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	5.1 (p 125)
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	5.1 (p 125)
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	4.4 (p 81)
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Appendix 3 (p 275)
Competing interests	26	Declare any competing interests of review authors.	Appendix 3 (p 275)
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Appendix 3 (p 275)

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

For more information, visit: http://www.prisma-statement.org/

Appendix 3

Mixed-methods systematic review publication

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JAN Leading Global Nursing Research WILEY

REVIEW

A mixed-methods systematic review of nurse-led interventions for people with multimorbidity

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Funding information
NHS Greater Glasgow and Clyde

Abstract

Aims: To identify types of nurse-led interventions for multimorbidity and which outcomes are positively affected by them.

Design: Mixed-methods systematic review following the Joanna Briggs Institute (JBI) methods for convergent-integrated reviews. PROSPERO ID: CRD42020197956.

Data Sources: Cochrane CENTRAL, CINAHL, Embase and MEDLINE were searched in October 2020. Grey literature sources included OpenGrey, the Journal of Multimorbidity and Comorbidity and reference mining.

Review Methods: English-language reports of nurse-led interventions for people with multimorbidity were included based on author consensus. Two reviewers performed independent quality appraisal using JBI tools. Data were extracted and synthesized using a pre-existing taxonomy of interventions and core outcome set.

Results: Twenty studies were included, with a median summary quality score of 77.5%. Interventions were mostly case-management or transitional care interventions, with nurses in advanced practice, support to self-manage conditions, and an emphasis on continuity of care featuring frequently. Patient-centred outcomes such as quality of healthcare and health-related quality of life were mostly improved, with mixed effects on healthcare utilization, costs, mortality and other outcomes.

Conclusion: Interventions such as case management are agreeable to patients and transitional care interventions may have a small positive impact on healthcare utilization. Interventions include long-term patient management or short-term interventions targeted at high-risk junctures. These interventions feature nurses in advanced practice developing care plans in partnership with patients, to simplify and improve the quality of care both in the long and short-term.

Impact: This is the first mixed-methods review which includes all types of nurse-led interventions for multimorbidity and does not focus on specific comorbidities or elderly/frail populations. Using adapted consensus-developed frameworks for interventions and outcomes, we have identified the common features of interventions and their overall typology. We suggest these interventions are of value to patients and healthcare systems but require localization and granular evaluation of their components to maximize potential benefits.

KEYWORDS
comorbidity, literature review, mixed-methods, multimorbidity, nurse-led care, nurses, nurse's practice patterns, nursing, systematic review

1 | INTRODUCTION

People are living longer now than ever before and spending an increasing number of years in worsening health. The proportion of people living in the community with multimorbidity (two or more chronic conditions) is estimated to be around 33% (Nguyen et al., 2019), growing significantly with advanced age and increasing deprivation (Head et al., 2021). The cumulative burden of disease alongside socioeconomic drivers of poor health mean that those with multimorbidity are at increased risk of mortality, disability, functional decline, increased healthcare use and reduced quality of life (Xu et al., 2017). Isolation compounds this risk, as older people with multimorbidity who live alone are more likely to require emergency care than those who live with others (Barrenetxea et al., 2021). The structure of healthcare services also places people with multimorbidity at risk of care fragmentation and treatment burden (Morris et al., 2021).

Nurse-led care delivered by experienced nurses is comparable in quality to physician-led primary care (Laurant et al., 2018), but it should not simply be considered a replacement for doctor-led care. Nursing care is traditionally holistic and if provided in the context of a supportive and adequately resourced organization, builds on the foundation of a therapeutic relationship where patient's goals and wishes are central to their care (Bridges et al., 2013). Nursing interventions are ideally suited to supporting people with multimorbidity, for whom priorities may change with time and are not necessarily tied to specific conditions. To do this effectively, nurses require a robust evidence base to inform their practice (O'Connor et al., 2018).

2 | BACKGROUND

2.1 | Multimorbidity

Multimorbidity refers to the coexistence of two or more chronic conditions (van den Akker et al., 1996). Comorbidity also refers to concurrent chronic conditions, yet it differs from multimorbidity by focussing on a specific index condition to which others are considered comorbid (Feinstein, 1970).To adopt a multimorbidity framework in research or clinical practice requires one to accept that no condition holds precedence, and that clinical decisions are taken within the overall context of the person (Boyd & Fortin, 2010).

This distinction matters in the way interventions are developed and evaluated. Interventions for index conditions and comorbidities can be targeted and use disease-specific outcomes but may not be generalizable to people with multimorbidity. Multimorbidity interventions will be more generic in their design, and the selection of outcomes to measure their effectiveness is more difficult (Harrison et al., 2021).

We must also consider what constitutes a chronic condition. Diagnosed diseases such as asthma or diabetes meet this requirement. But in the context of the person, symptoms (such as breathlessness or pain) or risk factors (such as obesity or poverty) are also important (Willadsen et al., 2016). The number of chronic conditions which are considered is also a concern (Fortin et al., 2012), as identifying multimorbidity from a small number of conditions may limit the generalizability of findings.

The strongest evidence to support interventions for concurrent conditions comes from studies which focus on specific disease clusters, or improving outcomes of common comorbidities, such as depression (Smith et al., 2021). Most multimorbidity interventions are evaluated using disease-specific outcomes (Xu et al., 2017), theoretically limiting the generalizability of these effects to groups with different combinations of disease. Approaches which are patient-oriented and support self-management are increasingly viewed as essential (Poitras et al., 2018; Smith et al., 2021).

2.2 | Nurse-led care

The concept of person-centred (or person-oriented) care underpins much of contemporary health policy but is particularly associated with nursing, providing a theoretical framework on which nursing interventions can be planned, implemented and evaluated. Key processes in person-centred nursing include engaging with patients, shared decision-making, creating a sympathetic presence, providing for physical needs and working with the patient's beliefs and values. Evaluating the effectiveness of such interventions should incorporate patient satisfaction, the level of involvement they have with care, their feelings of well-being, and the presence of a therapeutic culture (McCormack & McCance, 2006).

Community-based nurse-led interventions cover a diverse range of areas including walk-in clinics, primary care clinics, smoking cessation, women's health and healthcare for homeless persons. These types of interventions have been shown to improve access to healthcare, symptom management, and a range of disease-specific measures (Randall et al., 2017). Conversely, there is strong evidence to suggest that peri-discharge interventions of varying complexity are not effective in reducing hospital reattendance when compared with usual care (Wong et al., 2021). We cannot, however, generalize these findings to people with multimorbidity.

2.3 | Definitions

Based on the work of Boyd and Fortin (2010), Le Reste et al. (2013) and Willadsen et al. (2016), we define multimorbidity as the coexistence of two or more chronic conditions, where no condition holds precedence. Conditions are not restricted to diagnosed chronic diseases and can include biopsychosocial and somatic risk factors.

Nurse-led interventions were required to satisfy at least one of the following requirements: (1) the service is led by a senior (possibly consultant) nurse, (2) nurses manage and are accountable for a caseload of patients or (3) nurses practice with a discernible degree of autonomy compared with medically led care.

2.4 | Rationale for review

Previous reviews established that interventions which are person-oriented and incorporate self-management have the potential to improve outcomes in persons with multimorbidity (Crowe et al., 2016; Poitras et al., 2018; Smith et al., 2021). However, the evidence-base for certain types of nursing interventions for this group has not provided robust evidence of their impact on a wide range of outcomes (Lupari et al., 2011). Given the important role person-centred care plays in nursing practice (McCormack & McCance, 2006), we believe a review which seeks to categorize and evaluate nurse-led interventions for people with multimorbidity is warranted.

3 | THE REVIEW

3.1 | Aims

This review aims to identify what types of nurse-led interventions are effective in improving outcomes for people with multimorbidity.

3.1.1 | Specific objectives

1. To identify and categorize the different types of nurse-led interventions for people with multimorbidity, and
2. To identify which outcomes are improved by nurse-led interventions for people with multimorbidity.

3.2 | Design

This review follows the Joanna Briggs Institute (JBI) guidance for mixed-methods systematic reviews using a convergent-integrated approach (Lizarondo et al., 2020). This involves simultaneous analysis of qualitative and quantitative findings. Evidence grading is not recommended due to heterogeneity of sources. We have instead sought to classify whether different interventions have an effect which is best described as 'mostly improved', 'mostly unaffected', or 'mixed'. The review was registered on PROSPERO in October 2020 (ID: CRD42020197956), and is reported following the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) 2021 guidance (Page et al., 2021).

3.3 | Search methods

3.3.1 | Databases

Cochrane CENTRAL, CINAHL, Embase and MEDLINE were searched from inception using the terms in Table 1, which were based on a comprehensive list of synonyms from a recent systematic review (Makovski et al., 2019). All searches were conducted in October 2020. File S1 details search strategies.

3.3.2 | Additional sources

OpenGrey and the Journal of Multimorbidity and Comorbidity were searched in February 2021 (see File S1). The reference lists of articles included in the review, systematic reviews identified during scoping (Crowe et al., 2016; Poitras et al., 2018; Smith et al., 2021) and screening (Deschodt et al., 2020; Gordon et al., 2019; Latour et al., 2007; Lupari et al., 2011; Massimi et al., 2017; Morilla-Herrera et al., 2016) were also searched.

3.3.3 | Inclusion/exclusion criteria

Peer-reviewed research using qualitative, quantitative or mixed-methods to evaluate nurse-led interventions for people with multimorbidity were eligible. We applied the definitions of nurse-led care and multimorbidity as outlined earlier. Only English-language sources were included. Articles which dealt with specific clusters of conditions, only mental-health conditions or those which assumed multimorbidity purely on the basis of advanced age or frailty were excluded.

3.3.4 | Screening for eligibility

The first author applied inclusion/exclusion criteria to titles/abstracts and borderline decisions were agreed among the remaining authors. The first author read all full-text articles, with the role of second reviewer being shared between the second/third authors. Decisions were agreed between the group. Endnote (The EndNote Team, 2013) and Rayyan (Ouzzani et al., 2016) were used to manage and screen citations.

3.4 | Search outcome

The search outcome is detailed in Figure 1. Three thousand four hundred and twenty citations were retrieved, deduplicated and

TABLE 1 Search terms employed

Multimorbidity terms	Nurse-led care terms		
Multimorbidity	Nurse led		
Multi-morbidity	Nurse-led		
Multi morbidity	Nurse managed		
Multimorbidities	Nurse-managed		
Multi-morbidities	Nurse based intervention		
Multi morbidities	Nurse-based intervention		
Multimorbid	Primary nurse		
Multi-morbid	Primary nurses		
Multi morbid	Primary nursing		
Comorbidity	Nurse practitioner		
Co-morbidity	Nurse practitioners		
Co morbidity	Practitioner nurse		
Comorbidities	Practitioner nurses		
Co-morbidities	Advanced practice nurse		
Co morbidities	Advanced practice nurses		
Comorbid	Advanced practice nursing		
Co-morbid	Nurse specialist		
Co morbid	Nurse specialists		
Multiple chronic conditions	Specialist nurse		
Multiple chronic illnesses	Specialist nurses		
Multiple chronic diseases	Specialist nursing		
Multiple conditions	Nurse clinician		
Multiple illnesses	Nurse clinicians		
Multiple diseases	Nurse consultant		
Multiple diagnoses	Nurse consultants		
Morbidity pattern	Consultant nurse		
Morbidity patterns	Consultant nurses		
Polymorbidity	Case manager	**AND**	(nurse OR nurses OR nursing)
Poly-morbidity	Case-manager	**AND**	
Poly morbidity	Case management	**AND**	
Polymorbidities	Case-management	**AND**	
Poly-morbidities			
Poly morbidities			
Polypathology			
Poly-pathology			
Poly pathology			
Polypathologies			
Poly-pathologies			
Poly pathologies			
Pluripathology			
Pluri-pathology			
Pluri pathology			
Multipathology			
Multi-pathology			
Multi pathology			
Multipathologies			
Multi-pathologies			
Multi pathologies			
Multiple pathologies			
Disease cluster			
Disease clusters			

screened. Ninety-seven full-text articles were read and 88 were excluded, mostly for not being related to multimorbidity ($n = 34$), for not detailing a nurse-led intervention ($n = 11$), or a combination of both ($n = 8$). Thirty-six articles were retrieved through other means as detailed in Figure 1, of which 19 were eligible for inclusion. The final review includes 28 reports detailing 20 studies.

3.5 | Quality appraisal

Studies were independently appraised by two authors using JBI tools, and discrepancies were resolved through discussion between all three authors. A summary quality score (the percentage of checklist outcomes satisfied) was calculated for each study. Studies were not excluded based on quality. Full details are given in File S2.

3.6 | Data extraction and abstraction

Data were extracted using JBI tools. Citation, methodology, participant details, intervention details, setting, outcomes affected, and authors' conclusions were extracted. Intervention details were extracted qualitatively and background papers were consulted as necessary. All quantitative findings related to the review questions were extracted. Meta-analysis was not attempted, primarily due to heterogeneity in intervention types, but also in study designs, populations, multimorbidity definitions and outcome measures. Qualitative data were extracted at the level of themes, subthemes or other distinct concepts outlined in the results sections of included papers.

3.7 | Synthesis

A convergent-integrated approach requires that quantitative data be synthesized narratively so it can be integrated with the qualitative findings. Data extraction forms were imported into NVIVO 12 (QSR International Pty Ltd, 2018), and synthesis was theoretically guided by the use of existing frameworks alongside inductive coding.

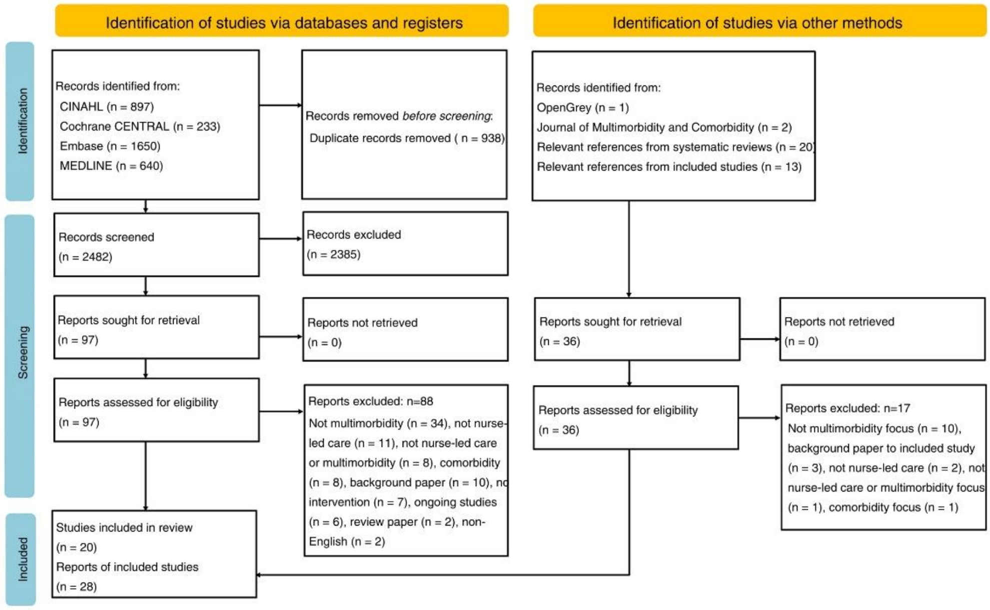

FIGURE 1 PRISMA flow diagram

3.7.1 | Interventions

The Cochrane Effective Practice and Organization of Care (EPOC) taxonomy of interventions (EPOC, 2015) provided a framework to describe interventions. Studies were indexed at two levels: components and interventions. Components were defined as *any described part of a complex intervention which is being delivered as an alternative to standard care*. The intervention type was defined as *the aspect of an intervention which most accurately summarizes the entire intervention*. For example if an intervention comprised the introduction of a nurse case-manager to coordinate care, and that case manager was able to provide home visits and transitional care, we would classify the intervention type as *case-management*, and the components as *(i) nurse home visits* and *(ii) transitional care*. To ensure that novel aspects of interventions were captured, inductive coding was also conducted.

3.7.2 | Outcomes

The Core Outcome Set for Multimorbidity Research (COSmm; Smith et al., 2018) details outcomes important to multimorbidity research. Extracted data were indexed under the 17 outcomes in the COSmm, and classified as positive, negative or unaffected. For quantitative data, $p < .05$ was considered significant and any appropriate effect size measurement was considered. Qualitative evidence deemed credible or unequivocal during extraction was also indexed under relevant outcomes. To avoid exclusion of relevant findings which did not fit within this framework, Inductive coding of outcomes was also undertaken by the first author.

4 | RESULTS

4.1 | Characteristics of included studies

Table 2 outlines included studies. Most employed quantitative or mixed-methods (*n* = 17), half were from the United States (*n* = 8) and Canada (*n* = 2), followed by the United Kingdom (*n* = 3), Spain (*n* = 2) and Sweden (*n* = 2). Hong Kong, Israel and Portugal each had one study. Quantitative studies were mostly quasi-experimental (*n* = 10), and all cohort studies (*n* = 4) were retrospective. Only three randomized controlled trials (RCTs) were found, and these included cluster and pragmatic designs. Qualitative studies (*n* = 4) and the qualitative component of mixed-methods studies (*n* = 2) were mostly descriptive or exploratory.

4.2 | Quality of included studies

The median summary quality score was 77.5% (interquartile range [IQR]: 58.8–89.0) for all studies (see Table 3). Two smaller

TABLE 2 Summary of included studies

Study, location and report(s) cited[a]	Design	Participants	Summary quality score[b]	Intervention	Summary of key findings [outcome measure][c]
Boyd et al., 2008 USA (Boyd et al., 2008; Sylvia et al., 2008)	Controlled (quasi-experimental) clinical trial (pilot)	150 (75 intervention, 75 control) Age > 65, multimorbid population identified using predictive modelling	67%	Guided Care Primary care nurse case-management intervention. Pilot tested 6 of 8 components	**Quality of healthcare—mixed** No significant improvement in any domain of patient satisfaction [PACIC] in intention to treat and per-protocol analyses. One domain (communication) significant improvement in regression model **Costs—mixed** Possible lower healthcare expenditure for Guided Care patients at lower risk of healthcare utilization
Boult et al., 2011 USA (Boult et al., 2008, 2011; Boyd et al., 2010; Leff et al., 2009)	Cluster randomized controlled trial	904 (485 intervention, 419 control) Age > 65, multimorbid population identified using predictive modelling	77%	Guided Care Primary care nurse case-management intervention	**Quality of healthcare—mostly improved** Small but significant improvement in overall patient satisfaction [PACIC] Some aspects of physician satisfaction improved but mostly unaffected [PCAT] 6/7 GC nurses moderately/very satisfied with role **Healthcare use—mostly unaffected** GC did not reduce emergency, secondary care, primary care or skilled nursing facility usage. Reduced home healthcare episodes. **Costs—mostly unaffected** No significant reduction in costs for GC patients
Chow & Wong, 2014 Hong Kong (Chow & Wong, 2014)	Randomized controlled trial (3 arms)	281 (98 control, 87 home visit arm, 96 phone arm) Age > 65, 2 or more conditions and admitting diagnosis of chronic respiratory disease, cardiac disease, T2DM or renal disease	85%	Transitional care intervention for hospital discharged adults. Delivered by advanced practice nurses and nursing students. One arm received home visits and telephone calls, one arm received telephone calls only	**Healthcare use—mixed** Readmission rates reduced at 84 days post-discharge in both intervention arms vs. control, significant in phone arm vs. control. No significant improvement in readmission at 28 days. **Health-related quality of life—mixed** Physical component of [SF-36] higher in intervention arms at baseline, 28 and 84 days. No significant difference in mental component [SF-36] **Self-efficacy—mostly improved** Both intervention arms had higher self-efficacy across all three timepoints compared with control [Short-form Chronic Disease Self-efficacy scale] **Self-rated health—mostly improved** Evidence of improvement in self-rated health in intervention groups at 28 and 84 days [Likert-type scale]
Dorr et al., 2008 USA (Dorr et al., 2008)	Controlled (quasi-experimental) clinical trial	3432 (1144 intervention, 2288 control) Age ≥ 65, complexity including multimorbidity referring criteria	89%	Intermountain nurse case management intervention (primary care based)	**Mortality—mixed** Deaths were lower in intervention group at 1 year, no difference by 2 years. **Healthcare use—mostly unaffected** No significant improvement in hospitalization and ED use were detected. Improvements were noted across outcomes in a diabetes subgroup

TABLE 2 (Continued)

Study, location and report(s) cited[a]	Design	Participants	Summary quality score[b]	Intervention	Summary of key findings [outcome measure][c]
Garcia-Fernandez et al., 2014 Spain (García-Fernández et al., 2014)	Retrospective analytical cohort study	255 (62 intervention, 193 control) Age ≥ 18, requirement that participants were complex including >2 diseases	55%	Hospital-based nurse case manager	**Mortality—mostly unaffected** No difference between groups in mortality at 90 days **Healthcare use—mostly unaffected** Non-significant difference between groups in readmission or resource utilization at 90 days **Activities of daily living—mostly improved** Intervention group had stable [Barthel index] score while control group declined **Quality of healthcare—mostly improved** Satisfaction with care and care continuity was higher in the case-managed group at 90 days **Caregiver support—mixed** [Caregiver Burden Index] remained stable in intervention group while control declined. No differences detected in [Caregiver Preparation Index]
Hanson et al., 2018 USA (Hanson et al., 2018; Takahashi et al., 2016)	Retrospective analytical cohort study	730 (365 intervention and 365 propensity-matched cohort) Age ≥ 60, multimorbid population identified using predictive modelling	100%	Mayo Clinic Care Transitions programme. Advanced practice nurse transitional care intervention	**Mortality—mixed** Significant reduction in mortality for intervention group at 30 days, not sustained at 90 or 180 days **Healthcare use—mixed** Significant reduction in readmissions and readmission/ED visits for the intervention at 30 days, not sustained at 90 or 180 days. No differences in bed days, ICU days, ED visits at any timepoint. **Costs—mixed** No significant reductions in costs for intervention group at 30 or 90 days. Further analysis revealed significant reduction at 30 days for the 80th percentile risk group
Hjelm et al., 2015 Sweden (Gustafsson et al., 2013; Hjelm et al., 2015)	Qualitative (focussed ethnography)	9 case managers (8 were nurses) 13 older (>75) people with multimorbidity (≥3 conditions and ≥3 hospital admissions in last year)	90%	Blekinge case management intervention Operates from outside healthcare system, CMs are non-clinical	**Quality of healthcare—mostly improved** Several illustrations highlighting how patients appreciated the CMs ability to develop therapeutic relationships with those in their care **Trust and advocacy—mostly improved** Several illustration highlighting that the CMs were trusted by patients and appreciated for their role in advocating for the patient
Hummel et al., 2017 USA (Hummel et al., 2017)	Retrospective analytical cohort study	82 (19 intervention, 63 control) Veterans Health Association patients, multimorbid population identified using predictive modelling	55%	Intensive Management Patient Aligned Care Team (imPACT) Nurse practitioner led interdisciplinary intervention, compared with physician-led PACT	**Proactive case finding—mixed** The imPACT patients had significantly greater referrals to hospice, suggesting better identification of palliative care needs. This was no longer significant in sensitivity analysis which removed people with cancer and dementia

TABLE 2 (Continued)

Study, location and report(s) cited[a]	Design	Participants	Summary quality score[b]	Intervention	Summary of key findings [outcome measure][c]
Jackson et al., 2016 USA (Jackson et al., 2016)	Retrospective analytical cohort study	35,174 (7468 intervention, 27,706 control). No age restriction, multimorbid population identified using predictive modelling	91%	Nurse home visits in addition to an existing transitional care intervention, compared with transitional care intervention without home visit	**Healthcare use—mostly improved** Home visits generated strong reduction in 30-day readmission and reduced 6-month inpatient admission in 4 of 6 subgroups stratified by risk. **Costs—mixed** 6-month inpatient costs were reduced in the highest risk strata but were unaffected in the remaining five subgroups
Karlsson & Karlsson, 2019 Sweden (Karlsson & Karlsson, 2019)	Qualitative (descriptive/ exploratory)	10 nurses providing home visits to people aged ≥65 with multimorbidity	50%	Follow-up 48–72 transitional care intervention. Nurse home visits post-hospital discharge	**Quality of healthcare—mostly improved** Some illustration of nurses improving satisfaction with healthcare by answering questions/ relieving anxieties at home visit **Communication—mostly improved** Some illustration to suggest face-to-face visit improves ability to assess patients holistically
Lupari, 2011 UK, Northern Ireland (Lupari, 2011)	Mixed-methods: controlled (quasi-experimental) clinical trial/ qualitative descriptive	590 (295 intervention, 295 control) Age > 65, multimorbid population identified using predictive modelling	Quant: 89% Qual: 90%	Community-based nurse case management intervention	**Health-related quality of life—mostly improved** Health-related quality of life improved across the three timepoints (12,24,36 months) for the intervention, control declined [EQ-5D + VAS] **Healthcare use—mostly improved** Bed days significantly reduced at all timepoints apart from 24 weeks. Hospitalization significantly reduced at 36 weeks but not 12 or 24. **Costs—mostly improved** Intervention group demonstrated a significant increase in QALYs at 9 months **Physical function—mostly improved** Function improved in the intervention group across the three time points while control declined [FIM/FAM] **Caregiver support—mixed** There was no significant difference between groups in caregiver strain [Caregiver Strain Index], however, qualitative illustrations suggested carers were supportive of intervention
Mallow et al., 2018 USA (Mallow et al., 2018)	Pre/post-test (quasi-experimental) study	30. Age ≥ 18, requires combination of chronic diseases and biopsychosocial risk factors (low income, uninsured, poor access to healthcare)	44%	ml SMART web application and telehealth intervention delivered by nurse practitioner	**Physiological measures—mostly improved** The ml SMART intervention was associated with significant improvements in blood pressure and glycaemic control, but only borderline significant weight reductions

TABLE 2 (Continued)

Study, location and report(s) cited[a]	Design	Participants	Summary quality score[b]	Intervention	Summary of key findings [outcome measure][c]
Markle-Reid et al., 2016 Canada (Markle-Reid et al., 2016)	Pre/post-test (quasi-experimental) study (pilot)	45 (37 completed follow-up) Age ≥ 65, requires diagnosis of diabetes and multimorbidity (≥2 other conditions)	78%	Aging, Community and Health Research Unit Community Partnership Program (ACHRU-CPP) Nurse-led interdisciplinary intervention to support self-management	**Mental health—mostly unaffected** No significant differences in depressive symptoms [CES-D] or anxiety [GAD-7] **Health-related quality of life—mixed** Small significant improvement in physical component of [SF-12], no improvement in mental component **Costs—mixed** Small cost reductions in some areas of healthcare offset an increase in the cost of diabetes care **Self-management behaviour—mostly unaffected** No improvements detected in diabetes self-care [Diabetes Self Care Activity Scale]
Markle-Reid et al., 2020 Canada (Markle-Reid et al., 2018; Miklavcic et al., 2020)	Randomized controlled trial	2 sites: Ontario: 159 (80 intervention, 79 control) Alberta: 132 (70 intervention, 62 control) Age ≥ 65, requires diagnosis of diabetes and multimorbidity (≥2 other conditions)	77%	Aging, Community and Health Research Unit Community Partnership Program (ACHRU-CPP) Nurse-led interdisciplinary intervention to support self-management.	**Mental health—mixed** Difference in depression [CES-D-10] favouring the intervention group in Ontario. No difference for depression in Alberta. Anxiety [GAD-7] unaffected at both sites. **Health-related quality of life—mixed** The mental component score of [SF-12] was higher in the Ontario intervention group. There was no difference in mental component score in Alberta, and there was no difference in physical component score at either site. **Costs—mixed** At both sites, small reductions in costs across healthcare services were offset by an increase in diabetes-related costs, indicating cost neutrality. **Self-management behaviour—mixed** There was a small significant improvement in diabetes self-management in Ontario. No difference was detected in Alberta [Summary of Diabetes Self-Care Activities] **Self-efficacy—mostly unaffected** No significant difference was detected in self-efficacy at either site [Self Efficacy for Managing Chronic Disease Scale]
Moran et al., 2008 UK, Wales (Moran et al., 2008)	Pre/post-test (quasi-experimental) study	116. Phase1: age ≥ 65, 2 or more chronic conditions and hospitalization risk factors. Phase 2: age ≥ 50 ≥ 1 chronic condition	67%	Flintshire case-management intervention. Community-based case-management intervention	**Healthcare use—mixed** 12-month post-intervention ED admissions were significantly lower, but differences in length of inpatient stay were not significant
Randall et al., 2015 UK, England (Randall et al., 2014, 2015)	Qualitative (descriptive/exploratory)	2 phases: Phase 1: 43 Phase 2: 45 Community matrons, patients, carers, managers, former commissioners, GPs, secondary care staff	80%	Community Matrons Community-based advanced nurse case-management intervention	**Quality of healthcare—mixed** There were many illustrations where patients and staff felt patient care had been improved by the intervention, but also gaps identified particularly in communicating with secondary care. **Communication—mostly improved** Communicating with the community matrons was seen as easy and preferable to going through GP surgery **Self-management behaviour—mostly improved** There were illustrations of participants engaged in good self-management behaviours, which were credited to the community matrons' intervention

TABLE 2 (Continued)

Study, location and report(s) cited[a]	Design	Participants	Summary quality score[b]	Intervention	Summary of key findings [outcome measure][c]
Sadarangani et al., 2019 USA (Sadarangani et al., 2019)	Mixed methods: pre/post-test (quasi-experimental) study, with qualitative descriptive/exploratory interviews	Quantitative phase: 126. Age ≥ 18, combination of >1 chronic conditions, psychosocial conditions and hospitalization risk. Qualitative phase: 40 stakeholders (patients, carers, administrators, nurses, social workers)	Quant: 67% Qual: 80%	Community-based health home. Case-management intervention delivered by a registered nurse navigator with interdisciplinary team	**Mental health—mostly improved** Severe depression was reduced at 12 months [Geriatric Depression Scale]. There was also a reduction in loneliness [UCLA Loneliness Scale], and a borderline significant improvement in cognitive impairment [Orientation Memory Cognition Tool] **Health-related quality of life—mostly improved** There was a significant increase in the number of people reporting good quality of life at 12 months [Revised Dementia Quality of Life Self-Esteem subscale] **Healthcare use—mixed** There was a significant reduction in ED use over the preceding 12 months but no difference in hospitalization. **Prioritization—mostly improved** There was qualitative evidence of nurses engaging in patient-centred goal setting, and that patients appreciated this approach **Self-management behaviour—mostly improved** There was qualitative evidence of patients adopting positive health behaviours as a result of intervention **Nutrition—mostly improved** There was a significant reduction in proportion of those at 'high nutritional risk' at 12 months [DETERMINE checklist] **Falls risk—mostly unaffected** The proportion of those at 'high-risk' of falls was marginally higher post-intervention [STEADI assessment]. Authors attribute this to likely disease progression or improved detection of high-risk individuals. **Pain—mostly improved** There was a significant reduction in the number of people reporting poorly controlled pain at 12 months [Modified Universal Pain Assessment Tool] **Proactive case-finding—mixed** There was qualitative-only evidence to indicate the intervention improved early detection of high-risk patients and appropriate referral **Disease management—mostly improved** There was qualitative evidence to indicate nurses provided effective disease management and early detection of deterioration in health status **Trust and advocacy—mostly improved** There was qualitative evidence to indicate nurses provided an advocacy role for the patients with other health and social care providers **Caregiver support—mostly improved** There was qualitative evidence to suggest nurses were involved in proactively identifying and supporting caregivers

TABLE 2 (Continued)

Study, location and report(s) cited[a]	Design	Participants	Summary quality score[b]	Intervention	Summary of key findings [outcome measure][c]
Steinman et al., 2018 Israel (Steinman et al., 2018)	Cluster-controlled (quasi-experimental) clinical trial	1218 (622 intervention, 596 control). Age 45–94, 3 or more chronic conditions, high hospitalization risk determined by predictive modelling	89%	Comprehensive Care of Multimorbid Adults Project (CC-MAP) Primary care case-management intervention, based on Guided Care model	**Prioritization - mostly improved** There was a significant increase in the number of medication changes and symptom-focussed medication changes (yet no increase in number of medications) in the intervention group, interpreted as a 'fine-tuning' of medications in a patient-centred manner
Taveira et al., 2019 Portugal (Taveira et al., 2019)	Pre/post test (quasi-experimental) study	50. Adults (no age restriction) ≥2 chronic illnesses	33%	Primary care nurse case manager within an integrative care team	**Healthcare use—mostly improved** Reductions in ED admission, basic ED usage, family doctor and specialist consultations and inpatient admissions were all reduced.
Valdivieso et al., 2018 Spain (Valdivieso et al., 2018)	Controlled (quasi-experimental) clinical trial (3 arms)	472 (78 telehealth arm, 168 phone arm, 170 control) Age ≥ 18, multimorbid population identified using predictive modelling	56%	Hospital case-management nurse intervention. Phone arm made contact by telephone only, telehealth arm also used Bluetooth-enabled devices for physiological monitoring.	**Mortality—mostly unaffected** No differences detected in mortality between groups at 12 months **Mental health—mostly improved** The telephone group saw a reduction in cognitive impairment [Pfeiffer Score] over 12 months, but not the telehealth group **Health-related quality of life—mostly improved** Both intervention arms were associated with improved [EQ-5D] scores, and the telehealth group also had improved [EQ-5D VAS] at 12 months **Activities of daily living—mostly improved** The telephone group had improved functional ability/ADLs at 12 months compared with control [Barthel Index] **Healthcare use - mostly unaffected** There was no reduction between groups for any aspect of healthcare utilization.

Abbreviations: ADL, activities of daily living; CM, case manager; ED, emergency department; GC, Guided Care; ICU, intensive care unit; QALY, quality-adjusted life years; T2DM, type 2 diabetes mellitus.

[a] Study title decided based on either the principal investigator (if known), or the first author of the most recent or significant publication. This does not signify authorship as determined by the publication authors.

[b] Summary quality scores calculated as a percentage of the domains in the scoring tool which were scored 'yes'.

[c] Outcome measures in parentheses where identified by study authors.

TABLE 3 Summary quality scores

Study type	Number of studies[a]	Summary quality score Median	Range	Interquartile range
Randomized controlled trials	3	77.0	77–85	77.0–81.0
Quasi-experimental studies	10	67.0	33–89	58.8–86.3
Retrospective cohort studies	4	73.0	55–100	55.0–93.3
Qualitative studies	5	80.0	50–90	80.0–90.0
All studies	20	77.5	33–100	58.8–89.0

[a] Number of studies greater than 20. Mixed-methods studies scored on both qualitative and quantitative components.

quasi-experimental studies scored less than 50% but did not add unique findings. The most common issues in RCTs related to blinding of participants or clinicians (*n* = 3). Absence of control groups (*n* = 5) and single measurements of outcomes (*n* = 6) were common in quasi-experimental studies. Qualitative studies lacked statements locating the researcher culturally or theoretically (*n* = 5) and most did not consider the impact of the researcher on the research (*n* = 3). Failure to discuss theory and reflexivity in qualitative research suggests that studies have been conducted in a value-neutral or atheoretical manner, which is at odds with the assumptions of most qualitative approaches (Braun & Clarke, 2021; Sandelowski, 1993) and limits the transferability of findings. We have highlighted which results are based purely on qualitative findings. File S2 provides further detail.

4.3 | Participant characteristics

The average age of participants was reported in 13 studies and ranged from 38.0 to 83.1 (median: 75.6, IQR: 73.9–76.5), reflecting the fact that most (*n* = 11) studies targeted older adults. Nine studies reported an average number of chronic conditions, ranging from 2.85 to 11.5 (median: 4.45, IQR: 4.02–8.00). All studies recruited participants from both sexes and were broadly evenly distributed.

4.4 | Identification of multimorbidity

Ten studies required two or more chronic conditions to be eligible (Chow & Wong, 2014; García-Fernández et al., 2014; Gustafsson et al., 2013; Hjelm et al., 2015; Karlsson & Karlsson, 2019; Markle-Reid et al., 2016, 2018; Miklavcic et al., 2020; Moran et al., 2008; Randall et al., 2014, 2015; Sadarangani et al., 2019; Taveira et al., 2019). Two of these studies—a pilot study and subsequent RCT (Markle-Reid et al., 2016, 2018; Miklavcic et al., 2020)—also required a diagnosis of diabetes, but the intervention was multimorbidity-focussed. Seven studies used predictive models to identify intensive healthcare users with multimorbidity (Boult et al., 2008, 2011; Boyd et al., 2010, 2008; Hanson et al., 2018; Hummel et al., 2017; Jackson et al., 2016; Leff et al., 2009; Lupari, 2011; Sylvia et al., 2008; Takahashi et al., 2016; Valdivieso et al., 2018). One study required three conditions and also employed a predictive model (Steinman et al., 2018). The remaining two studies identified multimorbid populations through clinician judgement (Dorr et al., 2008) and a combination of chronic disease and risk factors (Mallow et al., 2018).

4.5 | Intervention components

File S3 details the adapted EPOC taxonomy. Interventions were complex, with the average intervention comprising 5.75 components (range 2–12). Figure 2 outlines components by frequency.

Common components included nurses in advanced practice (*n* = 16), case-management (*n* = 13) supporting self-management (*n* = 10), discharge planning/transitional care (*n* = 8) and interventions to improve continuity of care (*n* = 8). A common theme was involvement of an experienced nurse managing complex care to reduce healthcare utilization or improve the quality of patient care. Interventions were delivered either as a continuous intervention (with the nurse serving as primary caregiver) or targeted at high-risk transitions, such as hospital discharges.

4.6 | Intervention type and the effect on outcomes

Interventions were further categorized by the component which most accurately summarized them overall (Figure 3). Most were case-management interventions (*n* = 12), followed by transitional care interventions (*n* = 4), interventions to support self-management (*n* = 2), nurse-led interdisciplinary team interventions (*n* = 1) and ICT interventions (*n* = 1).

Table 4 outlines the effects recorded in included studies, grouped by intervention type.

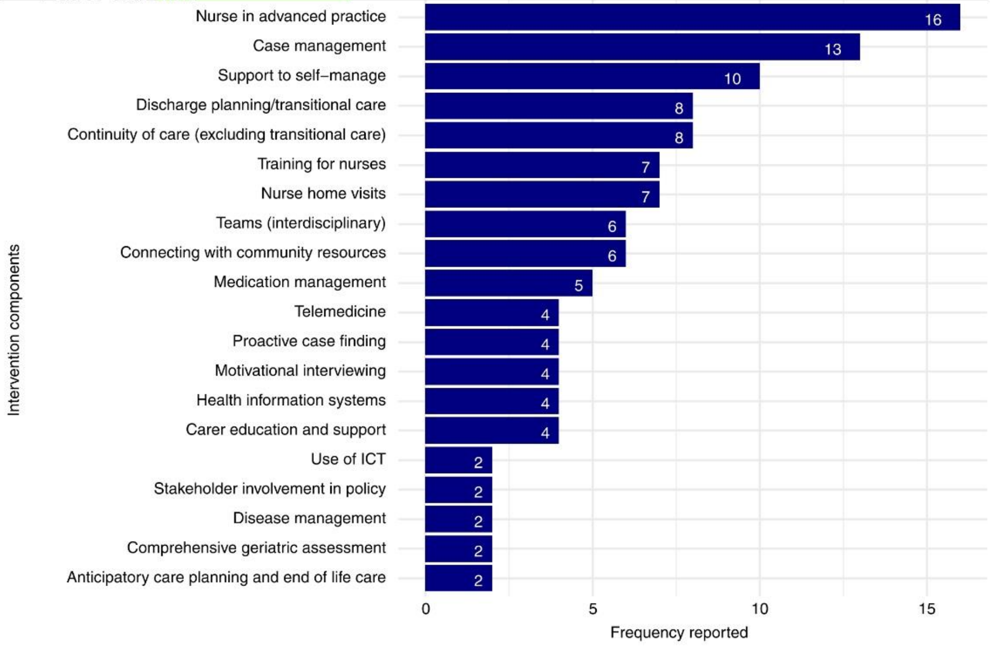

FIGURE 2 Intervention components

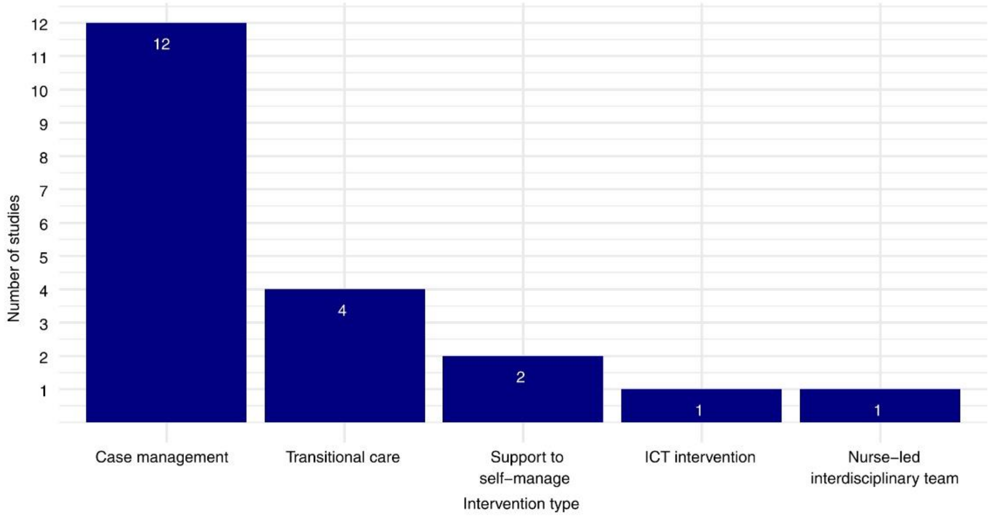

FIGURE 3 intervention types

TABLE 4 The effect of interventions on outcomes

	Case-management	Transitional care	Supported self-management	Nurse-led interdisciplinary team	ICT interventions
Health-related quality of life	**Mostly improved** (Lupari, 2011; Sadarangani et al., 2019; Valdivieso et al., 2018)	**Mostly improved** (Chow & Wong, 2014)	**Mixed** (Markle-Reid et al., 2016, Markle-Reid et al., 2018; Miklavcic et al., 2020)		
Mental health	**Mixed** (Sadarangani et al., 2019; Valdivieso et al., 2018)		**Mostly unaffected** (Markle-Reid et al., 2016, Markle-Reid et al., 2018; Miklavcic et al., 2020)		
Mortality	**Mixed** (Dorr et al., 2008; García-Fernández et al., 2014; Valdivieso et al., 2018)	**Mixed** (Takahashi et al., 2016)			
Self-rated health		**Mostly improved** (Chow & Wong, 2014)			
Self-management behaviour	**Mostly improved** (Randall et al., 2014, Randall et al., 2015; Sadarangani et al., 2019)[a]		**Mixed** (Markle-Reid et al., 2016, Markle-Reid et al., 2018; Miklavcic et al., 2020)		
Self-efficacy		**Mostly improved** (Chow & Wong, 2014)	**Mostly unaffected** (Markle-Reid et al., 2018; Miklavcic et al., 2020)		
Caregiver burden/ support	**Mixed** (García-Fernández et al., 2014; Lupari, 2011; Sadarangani et al., 2019)				
Pain	**Mostly improved** (Sadarangani et al., 2019)				
Activities of daily living	**Mostly improved** (García-Fernández et al., 2014; Valdivieso et al., 2018)				
Physical function	**Mixed** (Lupari, 2011)				
Physiological measures					**Mixed** (Mallow et al., 2018)
Disease management	**Mostly improved** (Sadarangani et al., 2019)[a]				
Nutrition	**Mostly improved** (Sadarangani et al., 2019)				
Falls risk	**Mostly unaffected** (Sadarangani et al., 2019)				
Communication	**Mostly improved** (Randall et al., 2014, Randall et al., 2015)[a]	**Mixed** (Karlsson & Karlsson, 2019)[a]			

(Continues)

TABLE 4 (Continued)

	Case-management	Transitional care	Supported self-management	Nurse-led interdisciplinary team	ICT interventions
Prioritization	**Mostly improved** (Sadarangani et al., 2019; Steinman et al., 2018)				
Trust and advocacy	**Mostly improved** (Gustafsson et al., 2013; Hjelm et al., 2015; Sadarangani et al., 2019)[a]				
Healthcare use	**Mixed** (Boult et al., 2011; Dorr et al., 2008; García-Fernández et al., 2014; Lupari, 2011; Moran et al., 2008; Sadarangani et al., 2019)	**Mostly improved** (Chow & Wong, 2014; Jackson et al., 2016; Takahashi et al., 2016)			
Costs	**Mixed** (Leff et al., 2009; Lupari, 2011; Sylvia et al., 2008)	**Mixed** (Hanson et al., 2018; Jackson et al., 2016)	**Mixed** (Markle-Reid et al., 2016, Markle-Reid et al., 2018; Miklavcic et al., 2020)		
Quality of healthcare (patient-rated)	**Mostly improved** (Boult et al., 2008; Boyd et al., 2010, Boyd et al., 2008; García-Fernández et al., 2014; Hjelm et al., 2015; Randall et al., 2014, Randall et al., 2015)	**Mixed** (Karlsson & Karlsson, 2019)[a]			
Quality of healthcare (nurse/physician rated)	**Mixed** (Boyd et al., 2010; Randall et al., 2014)				
Case-finding	**Mixed** (Sadarangani et al., 2019)			**Mixed** (Hummel et al., 2017)	

Note: Italicized outcomes not COSmm outcomes and were coded inductively.

Note: Mostly Improved = green, Mixed = amber, Mostly unnafected = red.

[a] Qualitative evidence only.

4.6.1 | Case-management interventions

Case-management interventions were characterized by comprehensive patient assessment, tailored care planning, (Boult et al., 2011; Boyd et al., 2008; Chow & Wong, 2014; Sadarangani et al., 2019; Steinman et al., 2018) and often focussed on improving continuity of care (Boult et al., 2011; Boyd et al., 2008; Lupari, 2011; Steinman et al., 2018; Taveira et al., 2019). Some case-managers had advanced clinical skills (Lupari, 2011; Randall et al., 2014), and were the primary healthcare provider, while others worked in partnership with the patient's primary care team (Boult et al., 2011; Boyd et al., 2008; Steinman et al., 2018). Several interventions required that case-managers undertake bespoke training (Boult et al., 2011; Boyd et al., 2008; Lupari, 2011; Moran et al., 2008; Steinman et al., 2018). Nurse case-managers were present across primary care (Boult et al., 2011; Boyd et al., 2008; Dorr et al., 2008; Steinman et al., 2018; Taveira et al., 2019), secondary care (García-Fernández et al., 2014; Valdivieso et al., 2018) and community settings (Hjelm et al., 2015; Lupari, 2011; Moran et al., 2008; Randall et al., 2015; Sadarangani et al., 2019).

Effect of case-management interventions

Case-management interventions had positive effects on health-related quality of life, self-management behaviour, pain and disease management, nutrition, activities of daily living, communication with healthcare providers, prioritization of needs, fostering trust and advocacy and the overall quality of care from the patient perspective (Table 4).

Effects on health services were mixed. While some studies noted reductions in bed-days and emergency care use for community-based interventions (Lupari, 2011; Sadarangani et al., 2019), two large studies of primary care interventions did not detect a reduction across the majority of interactions with healthcare services (Boult et al., 2011; Dorr et al., 2008). Two hospital-based interventions also did not detect reductions in healthcare use (García-Fernández et al., 2014; Valdivieso et al., 2018). Cost reduction and mortality were similarly mixed. A community intervention in Northern Ireland demonstrated a significant reduction in healthcare costs (Lupari, 2011), while a primary care-based intervention from the United States failed to generate significant reductions (Leff et al., 2009; Sylvia et al., 2008). Two studies involving hospital case-managers did not detect any reduction in mortality at 90 days (García-Fernández et al., 2014) and 12 months (Valdivieso et al., 2018), while a large study of a community-based nurse case-manager intervention (3432 participants) found significant differences in the proportion of deaths favouring the intervention group at 1 year, although despite a crude reduction at 2 years, significance was not sustained (Dorr et al., 2008).

Mixed effects were also noted for mental health, specifically depression, loneliness and cognitive impairment (Sadarangani et al., 2019; Valdivieso et al., 2018), as well as caregiver support (García-Fernández et al., 2014; Lupari, 2011; Sadarangani et al., 2019), physical functioning (Lupari, 2011), and quality of care from physician perspective (Boyd et al., 2010; Randall et al., 2014). Qualitative findings suggested case-finding for referral to other services may be improved by a community-based intervention, and quantitative findings indicated that there was no reduction in falls risk as a result of the same intervention (Sadarangani et al., 2019).

4.6.2 | Transitional care interventions

Transitional care interventions are relatively short-term and focus on the coordination of patient care and changes to the care process (EPOC, 2015); the interventions included in this review all targeted the transition from acute hospital to home (Chow & Wong, 2014; Hanson et al., 2018; Jackson et al., 2016; Karlsson & Karlsson, 2019). Home visits were common to all interventions however, one study compared a combined telephone and home visit service with a telephone-only service (and usual care) (Chow & Wong, 2014). One study examined the effect of a home visit by a nurse nested within an existing transitional care intervention (Jackson et al., 2016).

Effect of transitional care interventions

Transitional care interventions demonstrated positive effects on health-related quality of life, self-rated health, self-efficacy and healthcare use (Table 4). One study evidenced improvements in physical functioning, self-efficacy, self-rated health and reduced readmission within 84 days of discharge, although not within 28 days (Chow & Wong, 2014). Conversely, a propensity-matched cohort analysis of another intervention demonstrated a reduction in readmission and ED attendance at 30 days which was not sustained at 90 or 180 days (Takahashi et al., 2016). In a large US study (35,174 participants), the addition of a nurse home visit to an existing transitional care intervention also generated positive reductions in 30-day readmission, as well as reduced 6-month readmission in four of six risk strata (Jackson et al., 2016).

Mortality results were mixed, with evidence of un-sustained reductions in one study (Takahashi et al., 2016). Cost reductions were only evidenced for those with the highest risk of healthcare utilization, as determined by predictive modelling (Hanson et al., 2018; Jackson et al., 2016), suggesting that targeting such groups in this way may be cost-effective. Limited qualitative findings suggested a Swedish intervention may have improved communication and quality of healthcare from the patient perspective (Karlsson & Karlsson, 2019).

4.6.3 | Supported self-management interventions

Two studies from the same programme of research were predominantly focused on supporting self-management. The six-month intervention included home visits, group education sessions, case conferences and nurse-led care coordination. There were variations in delivery between study phases and sites, however, the above components were consistent throughout (Markle-Reid et al., 2016; Markle-Reid et al., 2018; Miklavcic et al., 2020).

Effect of supported self-management interventions

Effects varied between reports. It did not generate an overall reduction in costs, yet savings in some areas were explained to offset increases in others, achieving cost-neutrality. Mixed results were reported across studies for health-related quality of life and self-management. No improvement was noted in mental health and self-efficacy (Markle-Reid et al., 2016, 2018; Miklavcic et al., 2020).

4.6.4 | Nurse-led interdisciplinary team interventions

Interdisciplinary team working featured in six interventions, however, only one study specifically focussed on evaluating the effect of a nurse practitioner-led intensive management patient-aligned care team, comprised of a nurse practitioner (team leader), social worker, recreation therapist, administration coordinator and a part-time physician champion. This was compared with a less intensive physician-led team. The key features of the intervention involved 24/7 contact to either the nurse practitioner or physician, comprehensive interdisciplinary assessment and frequent follow-up, health education and coaching, hospital 'in-reach', co-attendance at appointments and connecting patients with community resources (Hummel et al., 2017).

Effect of nurse-led interdisciplinary team interventions

The intervention reported a crude improvement in identification and referral of people with palliative and end-of-life care needs, however, when the imbalanced distribution of people with cancer and dementia was removed in a sensitivity analysis, the difference was no longer significant (Hummel et al., 2017).

4.6.5 | Information and communication technology (ICT) interventions

The use of ICT and telehealth was present in many interventions, however only one intervention evaluated the effect of a nurse practitioner-led smart technology intervention to a cohort of adults with multimorbidity. The 12-week intervention made use of a patient-facing web application provided to participants on a tablet computer alongside a range of devices for physiological monitoring, such as Bluetooth-enabled scales, glucometer and sphygmomanometer. Participants were expected to use the application in place of attending the clinic and the nurse acted as primary clinician (Mallow et al., 2018).

Effect of ICT interventions

The small (30 participants) study reported improvements in some physiological measures (blood pressure and glycaemic control) but not others (weight control; Mallow et al., 2018).

5 | DISCUSSION

We have found that nurse-led interventions for multimorbidity are mostly either case-management or transitional care interventions, often employ a nurse in advanced practice and are focussed on simplifying care and supporting self-management. Effects on outcomes were mixed; case-management had positive effects on patient-centred outcomes, yet the impact on health service outcomes was inconsistent. Transitional care interventions were more consistent in reducing healthcare usage and reattendance, albeit with variations in the longevity of the effect. The overall aim of this review was to identify the types of nurse-led interventions which improve outcomes for people with multimorbidity; we conclude that interventions which focus on coordination and management of care in both the long- and short-term have the potential to improve patient-centred and patient-reported outcomes but are less consistent in improving health-service oriented outcomes such as usage and costs.

To better understand the types of nurse-led interventions which are most effective, we should locate these interventions in relation to established theory. First, interventions were generally grounded in the Chronic Care Model (Wagner et al., 2002). Importance was placed on the organization of healthcare services, and on connecting nurses and patients with resources available in the wider community. Productive interactions between nurse and patient were seen as essential to the shared development of care plans and to setting realistic goals and priorities about the individuals' care. Both case management and transitional care interventions tend to operate within this framework, albeit over different durations and in different settings.

Nested within the Chronic Care Model is the concept of supported self-management, which also underpinned many interventions in this review. Yet, studies which measured the effect interventions had on treatment burden were conspicuously absent, despite this being an important outcome to consider in multimorbidity research (Smith et al., 2018) and one which can negatively impact an individual's ability to self-manage multimorbid conditions (Boyd et al., 2014). Burden of Treatment Theory describes the complex interplay between the individual, the health system and their social network, and how these relationships mediate the individual's capacity to self-manage effectively (May et al., 2014). Validated tools exist to measure treatment burden in people with multimorbidity (Tran et al., 2014), and these should be deployed in future studies of similar interventions.

While interventions were spread between primary, secondary and community care, their orientation is closest to the generalist and person-centred approach of primary care. A primary care approach to multimorbidity care should include comprehensive assessment which considers interactions between the many drugs and conditions a person has, prioritization of care based on patient preferences, and individualized management and follow-up. All this should be centred around realistic and shared treatment goals (Muth et al., 2014).

We should also consider where this approach aligns with nursing models. At their most fundamental level, we suggest these interventions are grounded in primary nursing theory, where an individual nurse is responsible for an individual patient and for providing continuous care to them. This is in contrast with alternative and more common models such as team-based nursing (where nurses work together to care for a group of patients) and patient-allocation (where nurses care for a different allocation of patients each shift) (Fernandez et al., 2012). A primary nursing approach requires experienced nurses who are well-prepared to undertake this level of practice, which we note in the large number of interventions which required a nurse undertaking various levels of advanced practice.

Despite these elements of nurse-led interventions being present across case-management and transitional are interventions, the effect they had on outcomes was varied. Small improvements in patient-centred outcomes coupled with lesser impacts on healthcare services and health/disease outcomes are common features of most evaluations of multimorbidity interventions (Crowe et al., 2016; Smith et al., 2021) and this review finds that nurse-led interventions are no different. Interventions for this patient group are complex and multi-faceted, deployed within complex healthcare systems and target patients who are, by definition, also complex. These layers of complexity reflect the real-world challenges of developing and testing interventions for this group. It is challenging and resource-intensive to isolate the effects of the components or system factors which are responsible for observed effects (Poitras et al., 2018), but such approaches may be necessary in the future development of nurse-led interventions for people with multimorbidity. Adopting a primary care and primary nursing-based approach may provide a foundation on which to build such interventions.

5.1 | Limitations

Identifying studies concerning multimorbidity is challenging due to inconsistent terminology (Nicholson et al., 2019). We designed our definition of multimorbidity to account for this, however, it is possible some studies may have been missed if not identified by their authors as being concerned with multimorbidity. A similar problem exists in defining nurse-led interventions, although we sought to ensure the studies included met our agreed definition. Finally, only articles published in English were included, therefore some non-English studies may have been missed.

We adopted a convergent-integrated design primarily because we identified significant heterogeneity in study design and intervention type through scoping and because we wanted to include qualitative evidence in our analysis. Measuring certainty (through systems such as GRADE) is not recommended in convergent-integrated reviews, therefore we have been cautious in our interpretation of intervention effects. A similar issue exists regarding quality appraisal; we have applied a summary quality score to provide a summary of the extent to which quality outcomes were satisfied, but it is important to note that this does not allow for comparisons to be made between studies with different designs. Full details of quality assessment can be found in File S2.

5.2 | Future research

For those developing and evaluating complex interventions for people with multimorbidity, future research should focus on evaluating the components within these interventions, to better distil which elements are effective. RCTs can be conducted within existing interventions, and qualitative methods may be able to guide the selection of intervention components to be analysed. The way we interact with healthcare services has also been impacted by the COVID-19 pandemic, and while some countries are moving towards a degree of 'normality' in their practices, the effect of remote consultations, self-testing, shielding and such may have altered perspectives on what is desirable in an intervention. Further research should explore this in the context of multimorbidity.

Treatment burden is an important factor in multimorbidity research, and future evaluations should make use of validated tools to measure the effect of interventions on this outcome. Finally, researchers should strive to ensure a uniform terminology is employed to define multimorbidity in studies of interventions.

5.3 | Implications for practice

Nurses are well-placed to manage people with multimorbidity, as the transdiagnostic approach required compliments the person-centred approach of nursing care. Nurses working with people with multimorbidity should encourage involvement in decisions about their care and endeavour to create and regularly review care plans which align with the person and their needs.

6 | CONCLUSION

Nurse-led interventions for multimorbidity are characterized by the development and review of individualized patient-centred care plans by a primary nurse responsible for continuous care, working in partnership with the patient. They may constitute long-term interventions such as case management, or they may be brief and targeted at high-risk periods (such as transitional care). The evidence indicates that both approaches are acceptable to patients and may increase satisfaction, but the evidence for health service improvements is less clear. As researchers and practitioners, we need to consider the complexity of such interventions and the patients for whom they are designed, and we must plan our evaluations and care accordingly.

AUTHORS' CONTRIBUTIONS

All authors have agreed on the final version and meet at least one of the following criteria (recommended by the ICMJE*):

1. substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data;
2. drafting the article or revising it critically for important intellectual content.

*http://www.icmje.org/recommendations/

CM, BJ and MC conceived and designed the review. CM collected data and conducted analysis with support and verification from BJ and MC. CM drafted the article. CM, BJ and MC performed critical revision of the article and approved the final version for publication.

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No conflict of interest has been declared by the authors.

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Data sharing is not applicable to this article as no new data were created or analysed in this study.

PATIENT AND PUBLIC INVOLVEMENT

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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Appendix 4

MEDLINE search strategy

#	Searches
1	multiple chronic conditions/
2	exp comorbidity/
3	(multimorbidity or "multi-morbidity" or "multi morbidity" or multimorbidities or "multi-morbidities" or "multi morbidities" or multimorbid or "multi-morbid" or "multi morbid" or comorbidity or "co-morbidity" or "co morbidity" or comorbidities or "co-morbidities" or "co morbidities" or comorbid or "co-morbid" or "co morbid" or "multiple chronic conditions" or "multiple chronic illnesses" or "multiple chronic diseases" or "multiple conditions" or "multiple illnesses" or "multiple diseases" or "multiple diagnoses" or "morbidity pattern" or "morbidity patterns" or polymorbidity or "poly-morbidity" or "poly morbidity" or polymorbidities or "poly-morbidities" or "poly morbidities" or polypathology or "poly-pathology" or "poly pathology" or polypathologies or "poly-pathologies" or "poly pathologies" or pluripathology or "pluri-pathology" or "pluri pathology" or multipathology or "multi-pathology" or "multi pathology" or multipathologies or "multi-pathologies" or "multi pathologies" or "multiple pathologies" or "disease cluster" or "disease clusters").ab,ti.
4	Primary Nursing/
5	Practice Patterns, Nurses'/
6	exp Nurse Practitioners/
7	nurse specialists/ or nurse clinicians/
8	Advanced Practice Nursing/
9	exp Nurses/
10	exp Nursing/
11	exp Nurse's Role/
12	exp Nursing Care/
13	exp Case Management/ or exp Case Managers/
14	9 or 10 or 11 or 12
15	13 and 14
16	("nurse led" or "nurse-led" or "nurse managed" or "nurse-managed" or "nurse based intervention" or "nurse-based intervention" or "primary nurse" or "primary nurses" or "primary nursing" or "nurse practitioner" or "nurse practitioners" or "practitioner nurse" or "practitioner nurses" or "advanced practice nurse" or "advanced practice nursing" or "advanced practice nurses" or "nurse specialist" or "nurse specialists" or "specialist nurse" or "specialist nurses" or "specialist nursing" or "nurse clinician" or "nurse clinicians" or "nurse consultant" or "nurse consultants" or "consultant nurse" or "consultant nurses" or (("case manager" or "case-manager" or "case management" or "case-management") and (nurse or nurses or nursing))).ab,ti.
17	1 or 2 or 3
18	4 or 5 or 6 or 7 or 8 or 15 or 16
19	17 and 18

Appendix 5

Confirmation of ethical approval for cross-sectional study

NHS Greater Glasgow and Clyde
Safe Haven
West Wing, 2nd Floor
Smithhills Building 1
Smithhills Street
Paisley
PA1 1EB

3rd Sept 2021

Safe Haven Application Feedback

Project ID: GSH/21/AE/002
Project Name: Multimorbidity ED

All applications to the Safe Haven are reviewed separately by the Safe Haven team, the R&D Peer Review Committee (if appropriate), the Local Privacy Advisory Committee group and measured against a set of pre-defined criteria.

Your application has been through all relevant review processes and found to be acceptable as appropriate research for involvement with the Safe Haven. This letter includes both R&D Management and REC approval.

It is a requirement of your approval that you acknowledge use of the NHS Greater Glasgow & Clyde Safe Haven in any publications resulting from this project, and that you inform the Safe Haven of any such publications.

I am pleased to inform you, therefore, that your project has been approved.

Yours sincerely

Alison Hamilton
Safe Haven Project Manager
e: Alison.hamilton@ggc.scot.nhs.uk

1 of 2

TEM 09.001 Version 3.0

Appendix 6

Cross-sectional study publication

Check for updates

Original Article

JOURNAL OF
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& COMORBIDITY

Journal of Multimorbidity and Comorbidity
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Multimorbidity, disease count, mortality and emergency care use in persons attending the emergency department: a cross-sectional data-linkage study

Chris McParland[1,2], Mark A Cooper[1,2], David J Lowe[2,3], Bethany Stanley[3] and Bridget Johnston[1,2]

Abstract

Background: Multimorbidity (two or more concurrent chronic conditions) is associated with poorer health outcomes and increased healthcare utilisation in primary care and general populations. Less is known about the prevalence of multimorbidity in emergency department attenders, or its association with poor outcomes in this population.

Aim: This study sought to explore the relationship between multimorbidity, mortality and health-care utilisation in a large urban cohort of persons attending emergency departments.

Methods: Validated algorithms for the identification of 28 chronic conditions from ICD-10 codes were deployed on a cross-sectional sample of patients attending emergency departments in Glasgow, Scotland between April 2019 and March 2020. Analysis was conducted on complete cases (n=63,328) and compared with results from data with imputed missing values (n=75,723). Models adjusted for age, sex, deprivation and ethnicity were fitted to test for the association between (i) multimorbidity, (ii) complex multimorbidity, (iii) disease count and the following outcomes: admission to hospital, re-attendance at 30 and 90 days, and death during admission.

Results: Multimorbidity, complex multimorbidity and disease count were significantly associated with hospital admission and emergency department reattendance. Those with 1-3 conditions were at increased risk of inpatient mortality.

Conclusion: This study further evidences the impact of multimorbidity and disease burden on health-care use, and mortality to a lesser extent. Deployed algorithms were sufficiently sensitive to detect associations, despite limited access (21 months) to secondary-care data. This should allow for the construction of more robust models to prospectively identify persons at risk of poor outcomes in similar populations.

Keywords
Multimorbidity, emergency departments, ICD-10, multiple chronic conditions, routinely collected health data

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Background

Multimorbidity is the term used to define the co-occurrence of two or more chronic conditions in the same individual, where no particular focus is placed on a specific index condition[1]. It is strongly associated with advanced age and

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socioeconomic deprivation, and has been shown to predict poor outcomes including mortality, decreased quality of life, and increased healthcare utilisation, predominantly in the general population and primary care[2].

Measuring the prevalence of multimorbidity is a key area of research worldwide, although variability in the tools and methods of measurement limit the transferability of much of this research. Moreover, both the prevalence and characteristics of multimorbid populations may vary dependant on whether data was sourced from community dwelling persons, primary care or other service users, or hospital inpatients. Evidence from systematic reviews of prevalence studies indicate that primary care and the general population are the most frequent areas in which multimorbidity is measured by researchers[3-8]. Much less is known about the prevalence and patterns of multimorbidity in emergency department attenders, apart from smaller subgroups such as homeless persons[9], nursing home residents[10], and those attending with suspected acute coronary syndromes[11].

A 2017 systematic review provides some recommendations for better transferability in this field of research[12], including that between 25 and 75 conditions is the optimal amount for epidemiological studies. Through a targeted search of the international literature, Tonelli and colleagues developed and validated a series of logic-based algorithms which can be used to detect 30 chronic conditions with moderate to high reliability using routinely-collected patient data[13]. This was developed from an earlier list of 40 chronic conditions which were deemed important to multimorbidity research in primary care[14].

A significant benefit of these algorithms is that they have been validated using the two most recent iterations of the International Classification of Diseases (ICD-9 and ICD-10) and are therefore suitable for deployment in the health systems of any country which uses this system for reimbursement or general coding of diseases and risk factors. International variations in coding practices do exist. For example, in Scotland codes are mostly derived from hospital discharge letters, and there may be less incentive for comprehensive coding when compared with a reimbursement-based healthcare system. Nonetheless, the use of standardised algorithms still allows for better comparisons to be made between different studies.

Being able to reliably identify conditions from ICD codes also provides researchers with the ability to translate this raw data into diagnoses which are clinically-observable, and therefore recognisable to clinical practitioners. While many interventions designed to improve outcomes for people with multimorbidity use varied forms of analytics and predictive modelling to identify ‘high-risk’ healthcare users prospectively[15-19], it is also helpful if clinicians can stratify risk through recognition of key thresholds based on examination and history.

Given the value of identifying diseases and multimorbidity in this manner, we sought to explore the effectiveness of using an adapted version[20] of these algorithms to detect multimorbidity in emergency department (ED) attenders over a 12-month period, and to test hypotheses related to poorer outcomes in those with multimorbidity and increasing disease burden.

Aims

The overall aim of this study is to examine whether multimorbidity (the presence of two or more chronic conditions) is significantly associated with admission, mortality and reattendance in emergency department attenders, and if the odds of experiencing these outcomes increases with the number of conditions a person has. The following hypotheses were agreed a priori:

1. There will be a positive association between multimorbidity and admission to hospital, 30- and 90-day reattendance at the emergency department, and mortality during admission.
2. The risk of admission to hospital, 30- and 90-day reattendance at the emergency department, and mortality during admission will increase with the number of chronic conditions a person has.

We were additionally asked during peer-review to explore the significance of complex multimorbidity (three or more conditions affecting three of more body-systems) in relation to the above outcomes.

Methods

Study design

A cross-sectional study design was employed, with unique patient attendances at emergency departments during a 12-month period (April 2019 – March 2020) constituting the sample. For those who attended more than once, the first attendance within the study period was treated as the index attendance.

This study has been reported in adherence with the RECORD guidelines for cross-sectional studies using routinely collected data[21].

Setting

NHS Greater Glasgow and Clyde (NHSGGC) is the largest regional health board in Scotland, caring for a diverse population of 1.2 million people. NHSGGC serves a variety of rural and urban areas in and around Scotland’s most populous city. In this study we examine data for the predominantly urban population of the Glasgow City area. Cohorts and de-identified linked data were prepared by the West of Scotland Safe Haven at NHS Greater Glasgow and Clyde.

Participants

Any resident of the Greater Glasgow area aged 16 or older attending an emergency department within NHSGGC during the study period were included. We also considered all acute assessment units as emergency departments, the only exception being a small number of nurse-led minor injuries units which do not see medically unstable patients and cannot admit patients. In the event that someone attends such a unit with an illness or injury requiring emergency treatment rather than a minor injury, they would be re-directed to an emergency department and would therefore be included in the sample.

Variables

Outcome variables. All outcomes were coded as binary categorical variables and are considered co-primary. Admission to hospital is a mandatory coding item in emergency department data. Cases were coded for 30- and 90- day reattendance if a new emergency department attendance was recorded within these time periods of the index (first) attendance. Mortality and inpatient records were linked to emergency records by pseudonymised identifiers, and mortality at the various timepoints was calculated accordingly. Inpatient mortality was identified by linking inpatient and emergency department records to establish continuous inpatient 'episodes' from attendance to discharge, and cross-referencing date-of-death with these admission periods. Sufficient data were available to ensure that those attending at the end of the study period could be followed up for mortality (>12 months) and reattendance (>90 days).

Exposure variables. Tonelli and colleagues validated algorithms which allowed for identification of 30 chronic conditions from routinely-collected patient data[13]. Stokes and colleagues amended these algorithms to a list of 28, condensing three cancer diagnoses into one condition[20]. The algorithms utilise ICD-10 codes to detect conditions, and a small number have surgical exclusions. One condition (chronic kidney disease) also makes use of laboratory results. We deployed these algorithms to detect the 28 chronic conditions utilised by Stokes and colleagues[20], however, we were only able to identify chronic kidney disease using ICD-10 codes due to differences in the way laboratory results were reported. Each disease was coded as a binary categorical variable dependant on whether it could be said to be present at the time of the index attendance.

When assigning conditions to body systems (in order to identify complex multimorbidity) we used ICD-10 chapters as outlined by Harrison and colleagues[22]. Some conditions were coded across multiple chapters; therefore we have sought to categorise these under the most clinically-appropriate system/chapter. Full details are available in file S1.

Binary variables for multimorbidity/complex multimorbidity and a 7-level categorical variable for disease-count were also created, based on the above 28 conditions. In order to avoid those attending at the end of the study period being more likely to be classified as having multimorbidity (due to a longer 'look-back' period of historical data), we limited the available historical data to approximately 21 months before the index attendance. This is equal to the data available for someone attending on day 1 of the study period.

Confounder variables. Age, sex, ethnicity and deprivation data were available, and these were included in adjusted models in order to mitigate bias. Ethnicity is coded in Scottish health records using a standardised taxonomy. We adopted the six top-level categories as specified; however, we disaggregated the Arabic/Other ethnicity variable into two variables using granular data which was available. In analyses of inpatient mortality, ethnicity categories had to be collapsed to three variables (White/Asian/all other) in order to resolve issues with collinearity. The Scottish Index of Multiple Deprivation (SIMD) is a postcode-based measure of deprivation, in which deprivation is assessed across seven domains: income, employment, education, health, access to services, crime and housing[23]. SIMD is commonly analysed as a categorical variable, stratified into deciles based on level of deprivation, ranging from the lowest 10% (most deprived) to the highest 10% (least deprived).

Statistical methods

Descriptive statistics are presented for the whole sample and stratified based on the presence of multimorbidity and complex multimorbidity. Frequency counts, percentages and median/interquartile range (for non-parametrically distributed variables) are presented for exposures and outcomes.

Binomial logistic regression models were fitted for each outcome, and both crude (unadjusted) and adjusted models were calculated. We adjusted for age, sex, ethnicity and deprivation. Adjusted odds-ratios (ORs) and 95% Confidence Intervals (CIs) are reported here, full models are described in the supplemental files for both the complete-case analysis (file S2) and the post-imputation analysis (file S3).

All statistical analyses were conducted using R version 4.0.5.

Data linkage and cleaning

In Scotland, the Community Health Index (CHI) number is a unique identifier for each patient used in routinely collected health record databases, which enables patient records to be linked across different health datasets. Once linked using the CHI number, personal identifiers were removed (including CHI number) to ensure patient confidentiality, and access to the pseudonymised linked dataset was then provided via the Safe Haven. Data from five databases were linked; health-board wide emergency department data, mortality data, demographic data, ethnicity data and inpatient and day case records (SMR01).

A summary of data cleaning is as follows:

Emergency department data was extracted for the study period (1st April 2019 – 31st March 2020) and the first attendance for each patient was marked as the index attendance. Persons attending nurse-led minor injury units were excluded, as was the first attendance for those attending two departments in the same day; these represented transfers or redirected attendances at inappropriate sites, the inclusion of which would have artificially inflated reattendance figures. Binary variables were created which specified whether the patient was admitted, or reattended within 30 or 90 days. A numeric variable of the total ED attendances was also created. Attendances which did not have a patent identification number (required for linkage) and therefore could not be linked with any other data were also removed.

Inpatient records were included from 1st July 2017 (the earliest date available in the dataset) to the end of the study period. Inpatient records are generated for each change of ward, department or specialty, therefore each patient admission to hospital may comprise of several inpatient records. Through the use of admission, discharge and transfer codes and dates, these were collapsed into single records for each continuous inpatient admission. ICD-10 and intervention/procedure (OPCS-4) codes were also collapsed. Variables were created summarising all codes entered during each admission and the primary (first ICD-10 code) diagnosis. The date of admission was used as the index date for these codes.

All databases were then merged with the inpatient record, and those records which did not relate to a patient with an index emergency department attendance were discarded. Mortality data was used to create the binary mortality outcome variables using the index attendance dates, admission-discharge dates, and date of death.

The logic-based algorithms for detection of chronic conditions were then deployed (see file S1). ICD-10 codes and relevant exclusions were used to generate counts for whether a disease was detected from inpatient admissions; these were then referenced against the index dates to establish if the disease could be considered present at the time of the attendance. For conditions which required more than one hospitalisation, counts were assessed to check for presence of the disease. Finally, admission records were grouped by patient identifier and collapsed into a single record for each emergency attendance, detailing the conditions detected up to the point of presentation at the emergency department.

Missing data

Where a patient had no inpatient records (indicating no admission between 1st July 2017 and 31st March 2020), they were assumed to not have any chronic diseases for the purpose of this analysis. No strategy to impute diseases was employed.

Ethnicity data were missing in 15.9% of cases, and the distribution of known cases was extremely imbalanced. Deprivation data was missing in 0.06% of cases and was also imbalanced. We conducted a complete-case analysis, removing any cases which were found to lack ethnicity or deprivation data after linkage was completed. We also conducted analyses after imputing missing values to assess whether it impacted on findings. Missing ethnicity data were multiply imputed using a random forest classification algorithm[24], which has been shown to be effective in handling complex non-parametric data[25]. Due to the small number of cases missing deprivation data, median imputation was used. Accuracy of the Random Forest Model was assessed using the out-of-bag error rate. Further details available in file S4.

Ethical approval

Delegated research ethics approval was granted for linkage to National Health Service (NHS) patient data by the Local Privacy and Advisory Committee at NHS Greater Glasgow and Clyde. Approval for this study was granted on 3rd September 2021.

Results

Description of study sample

63,328 patients were included in the complete case analysis, and 75,723 in the imputed analysis. Figure 1 details how this sample size was arrived at, Table 1 describes the overall sample for complete case analysis and stratifies by multimorbidity and complex multimorbidity. We report the complete case analysis in the main body of this article, with additional data in the supplemental files for the post-imputation sample (file S5) and analysis (file S3).

Most (n=34,330, 54.2%) participants were female, a significant majority were white (n=59,056, 93.3%) and the median age was 54 (interquartile range (IQR): 36-70). Socioeconomic deprivation was also common (Figure 2).

Around one in five persons had multimorbidity (n=13,122, 21%). The most commonly detected conditions were chronic kidney disease (n=6,914, 10.9%), hypertension (n=5,818, 9.2%), chronic pulmonary disease (5,590, 8.8%), diabetes (n=4,591, 7.2%), and alcohol misuse (n=4,557, 7.2%). Table 2/Figure 3 describe the prevalence of all 28 conditions.

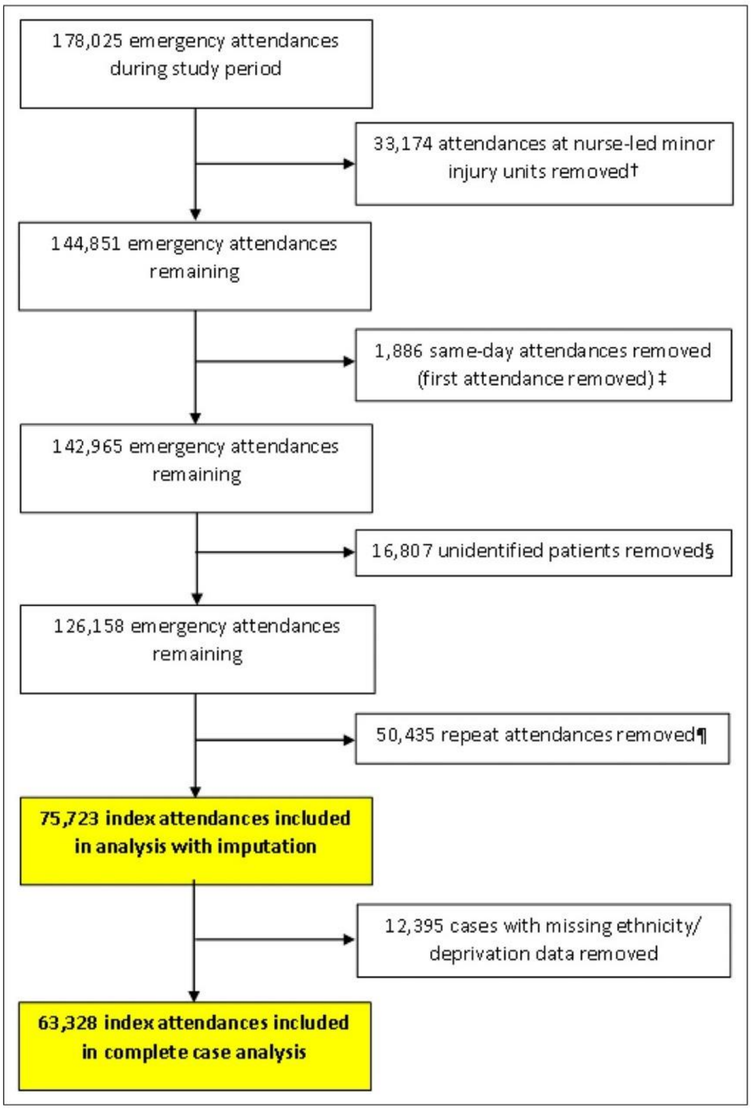

Figure 1. Sample selection flow diagram. †Nurse-led minor injury units can not admit patients directly, ‡In order to avoid inflation of reattendances when individuals were transferred between facilities, §Data-linkage can only be conducted on patients with a clinical identification number, ¶First attendance used as index to calculate reattendance, statistical assumptions prevent repeated inclusion of the same case.

Table 1. Sample description.

Sample	Overall	Multimorbidity	No Multimorbidity	Complex Multimorbidity	No Complex Multimorbidity
N	63,328	13,122	50,206	5,157	58,171
Demographics					
Male (%)	28,998 (45.8)	6,090 (46.4)	22,908 (45.6)	2,286 (44.3)	26,712 (45.9)
Female (%)	34,330 (54.2)	7,032 (53.6)	27,298 (54.4)	2,871 (55.7)	31,459 (54.1)
Age (median [IQR])	54 [36, 70]	71 [58, 81]	49 [33, 64]	73 [61, 81]	52 [35, 67]
Ethnicity					
White	59,056 (93.3)	12,774 (97.3)	46,282 (92.2)	5,021 (97.4)	54,035 (92.9)
Asian	2,589 (4.1)	286 (2.2)	2,303 (4.6)	116 (2.2)	2,473 (4.3)
African	602 (1.0)	31 (0.2)	571 (1.1)	11 (0.2)	591 (1.0)
Mixed/multiple	655 (1.0)	18 (0.1)	637 (1.3)	X	X
Other	303 (0.5)	7 (0.1)	296 (0.6)	X	X
Arabic	89 (0.1)	X	X	X	X
Caribbean	34 (0.1)	X	X	X	X
SIMD decile (median [IQR])	2 [1, 4]	2 [1,4]	2 [1,4]	2 [1,4]	2 [1,4]
Healthcare use					
Admitted (%)	27,362 (43.2)	10,058 (76.6)	17,304 (34.5)	4,084 (79.2)	23,278 (40.0)
Reattend <30 days (%)[†]	8,530 (13.8)	2,714 (22.7)	5,816 (11.8)	1,206 (24.6)	7,324 (12.9)
Reattend <90 days (%)[‡]	14,659 (23.1)	5,208 (42.5)	9,451 (19.3)	2,370 (49.4)	12,289 (21.8)
Total attendances (median [IQR])	1 [1, 2]	2 [1, 3]	1 [1, 2]	2 [1,3]	1 [1,2]
Mortality					
Died during admission (%)[§]	1,031 (3.8)	529 (5.3)	502 (2.9)	216 (5.3)	815 (3.5)
Died <30 days (%)[¶]	1,403 (2.2)	704 (5.4)	699 (1.4)	290 (5.6)	1,113 (1.9)
Died <6 months (%)[¶]	3,389 (5.4)	1,899 (14.5)	1,490 (3.0)	860 (16.7)	2,529 (4.3)
Died <12 months (%)[¶]	5,266 (8.3)	3,025 (23.1)	2,241 (4.5)	1,459 (28.3)	3,807 (6.5)

N = 12,395 cases were excluded from complete-case analysis for missing ethnicity (15.9%) and SIMD (0.6%) data.

Low-count values (<5) and those which risk secondary identification are marked with an 'X'.

[†] Represents whether any reattendances occurred within 30 days of index attendance. Percentage calculation excludes those who had died without reattending or were still admitted.

[‡] Represents whether any reattendances occurred within 90 days of index attendance. Includes reattendances within 30 days. Percentage calculation excludes those who had died without reattending or were still admitted.

[§] Percentage calculation based on admitted patients.

[¶] Inpatient and outpatient mortality, inclusive of mortality at earlier timepoints where applicable.

Emergency admission

Having multimorbidity (OR: 4.15, 95% CI: 3.96-4.35), or complex multimorbidity (OR: 3.41, 95% CI: 3.17-3.66) was significantly associated with admission to hospital. The risk was also significant for any level of disease burden, and highest for those with six or more chronic conditions (OR: 14.31, 95% CI: 9.76-20.91). Figure 4 provides a summary of effects.

30-day reattendance

As with admission, having multimorbidity (OR: 2.21, 95% CI: 2.09-2.34), or complex multimorbidity (OR: 2.20, 95% CI: 2.04-2.37) was significantly associated with 30-day reattendance at the emergency department. The risk was also significant for any level of disease burden, and highest for those with six or more chronic conditions (OR: 4.76, 95% CI: 3.54-6.34). Figure 5 provides a summary of effects. Those who had died before 30 days (without reattending) and those who were still admitted at 30 days were excluded from the analysis (n=1,553).

90-day reattendance

Again, the same association between multimorbidity (OR: 3.11, 95% CI: 2.96-3.26), complex multimorbidity (OR: 3.21, 95% CI: 3.01-3.41) and 90-day reattendance was detected. Disease count was significant at all levels and highest for those with six or more chronic conditions (OR: 10.79, 95% CI: 8.18-14.12).

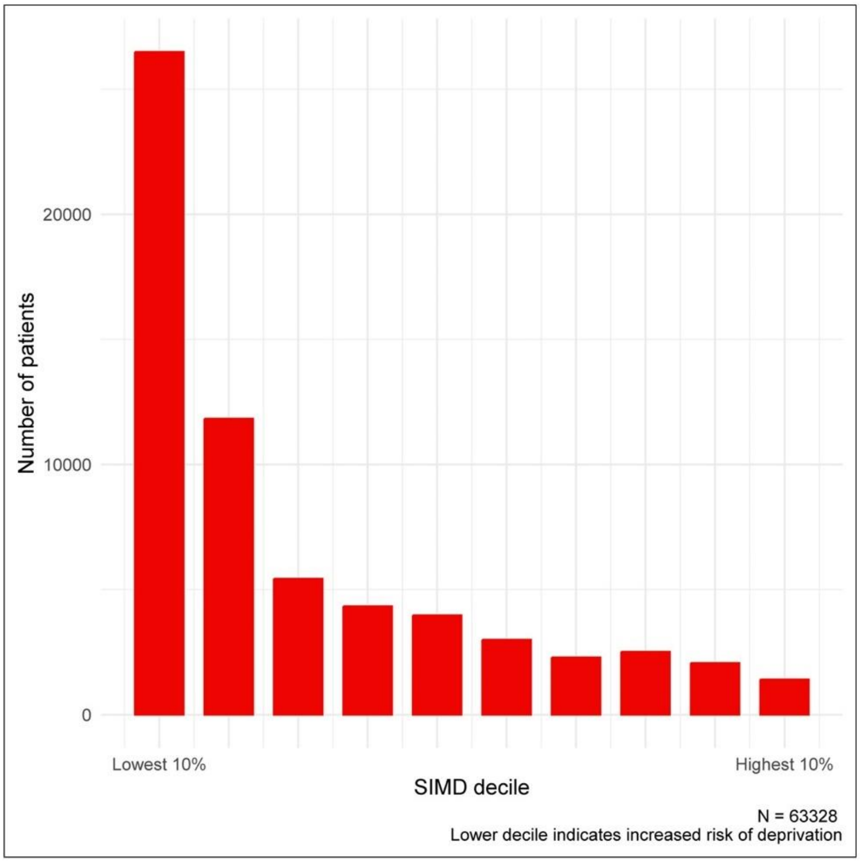

Figure 2. Scottish Index of Multiple Deprivation (SIMD) by decile (n=**63,328**).

Figure 6 provides a summary of effects. Those who had died before 90 days (without reattending) and those who were still admitted at 90 days were excluded from the analysis (n=2,087).

Inpatient mortality

Unlike previous models, the relationship between exposures and inpatient mortality was neither significant nor linear in terms of increasing disease burden. Multimorbidity (OR: 1.13, 95% CI: 1.00-1.29) and complex multimorbidity (OR: 0.99, 95% CI: 0.85-1.16) were not significantly associated with death during admission. People with 1,2 or 3 chronic conditions were significantly more likely to die during admission, although this association was not present for those with more conditions. We hypothesise this is likely due to the low number of individuals with 4, 5, 6 or more conditions in this analytical cohort. Only those who were admitted to hospital were included in this analysis (n=27,362) (Figure 7).

Comparison with imputed data. Post-imputation of missing data, our analysis of n=75,723 cases produced qualitatively similar results to the complete case analysis. The size of associations for both analyses are summarised in Table 3.

Table 2. Disease count and frequency in total sample.

Disease count	n	%
No chronic conditions	38,409	60.7
One chronic condition	11,797	18.6
Two chronic conditions	6,888	10.9
Three chronic conditions	3,754	5.9
Four chronic conditions	1,645	2.6
Five chronic conditions	605	1.0
6 or more conditions	230	0.4

Conditions by frequency and percentage affected

Disease	n	%	Disease	n	%
1. Chronic kidney disease	6914	(10.9)	15. Chronic pain	655	(1.0)
2. Hypertension	5818	(9.2)	16. Atrial fibrillation	601	(0.9)
3. Chronic pulmonary disease	5590	(8.8)	17. Rheumatoid arthritis	594	(0.9)
4. Diabetes	4591	(7.2)	18. Epilepsy	436	(0.7)
5. Alcohol misuse	4557	(7.2)	19. Peptic ulcer disease	412	(0.7)
6. Cancer	3048	(4.8)	20. Parkinson's disease	352	(0.6)
7. Asthma	2378	(3.8)	21. Schizophrenia	344	(0.5)
8. Chronic heart failure	2190	(3.5)	22. Severe constipation	341	(0.5)
9. Dementia	1896	(3.0)	23. Inflammatory bowel disease	305	(0.5)
10. Depression	1590	(2.5)	24. Irritable bowel syndrome	206	(0.3)
11. Stroke or TIA	1517	(2.4)	25. Psoriasis	200	(0.3)
12. Myocardial infarction	1281	(2.0)	26. Multiple sclerosis	109	(0.2)
13. Cirrhosis	1131	(1.8)	27. Peripheral vascular disease	18	(0.2)
14. Hypothyroidism	803	(1.3)	28. Chronic viral hepatitis B	15	(0.2)

Discussion

This study found that multimorbidity, complex multimorbidity and disease burden are associated with significantly increased odds of hospital admission in people attending the emergency department, as well as increased odds of reattendance within 30 or 90 days. The relationship between these and inpatient mortality is not significant, except for those with 1, 2 or 3 chronic conditions. We found that around one in five people attending the emergency department had multimorbidity, fewer than one in ten had complex multimorbidity, and that common conditions in this population included chronic kidney disease, hypertension, chronic pulmonary disease, diabetes and alcohol misuse.

We sought a 12-month dataset in order to capture seasonal variations in attendances, in particular the impact of winter flu and other viruses. However, the COVID-19 pandemic will also have contributed towards the end of the study period, although most likely in reducing the number of attendances rather than through an influx of infections. From the first reported case in NHSGGC in early March till the end of our study period on 31st March 2020, a total of 679 cases and zero hospitalisations had been recorded in the health board[26]. However, in the first 3 months of 2019 there were 92,129 ED attendances, compared to 81,904 for the same period in 2020- a reduction of approximately 11%[27].

A further point of interest is the comparatively low level of many conditions detected in this population when compared to a larger study conducted in England[20], which looked at hospital inpatients on a national level. We detected lower levels of hypertension (9.2% vs 26.5%), diabetes (7.2% vs 11.6%), asthma (3.8% vs 9.5%), depression (2.5% vs 6.7%), hypothyroidism (1.3% vs 4.9%), chronic pain

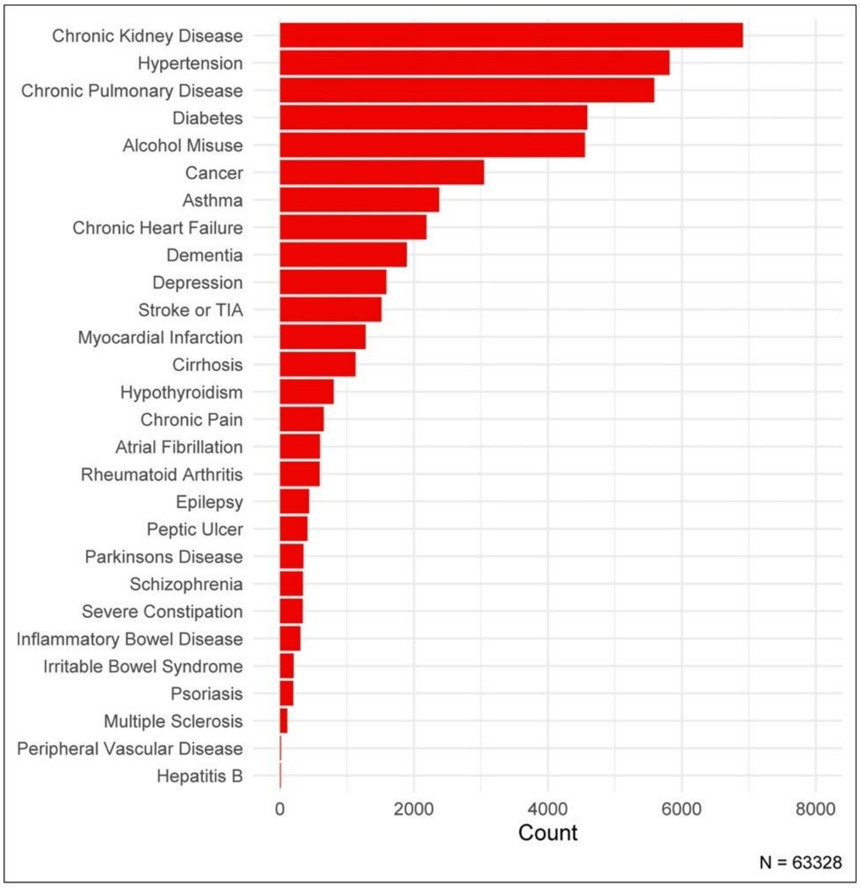

Figure 3. Disease frequency count in complete case analysis (n=63,328).

(1.0% vs 8.1%), rheumatoid arthritis (0.9% vs 2.4%), epilepsy (0.7% vs 1.9%), severe constipation (0.5% vs 2.9%), inflammatory bowel disease (0.5% vs 1.7%) and irritable bowel syndrome (0.3% vs 1.2%). While many of the other levels were comparable, a small number were more prevalent in our population, notably alcohol misuse (7.2% vs 3.0%). The absolute numbers of people with a history of myocardial infarction, stroke/TIA and cirrhosis were low in both populations, however our cohort had approximately double the proportion for all three (2.0% vs 1.2%, 2.4% vs 1.4%, and 1.8% vs 0.8% respectively).

We would suggest that these differences are more readily attributable to emergency department attending populations than to geographical differences alone, although there may also be differences when comparing this predominantly urban sample with other rural or mixed samples, or indeed when comparing secondary with primary care data. A large epidemiological study of multimorbidity conducted in Scotland by Barnett and colleagues using primary care data[14] detected higher levels of several diseases compared to the emergency department sample, including depression (2.5% vs 8.2%), hypertension (9.2% vs 13.4%), asthma (3.8% vs 6.0%), rheumatoid arthritis (0.9% vs 3.4%) and irritable bowel syndrome (0.3% vs 3.0%). Conversely, others were more prevalent in the emergency department sample, including alcohol

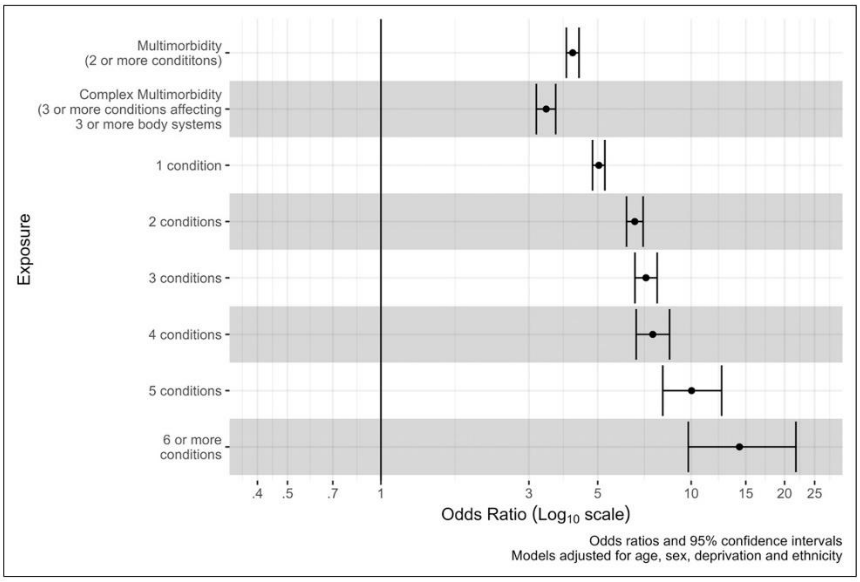

Figure 4. The association between multimorbidity, complex multimorbidity, disease-count and admission: complete case analysis (n=63,328).

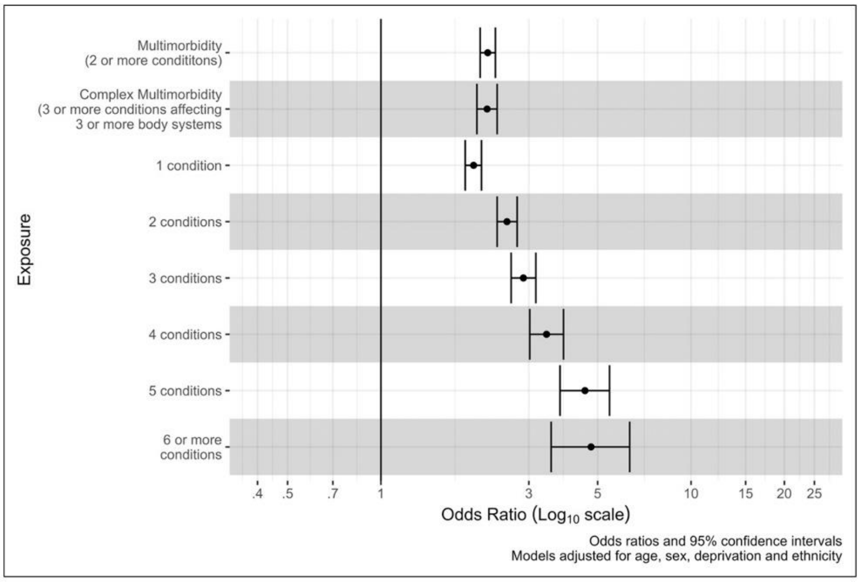

Figure 5. The association between multimorbidity, complex multimorbidity, disease-count and 30-day reattendance: complete case analysis (n=61,775).

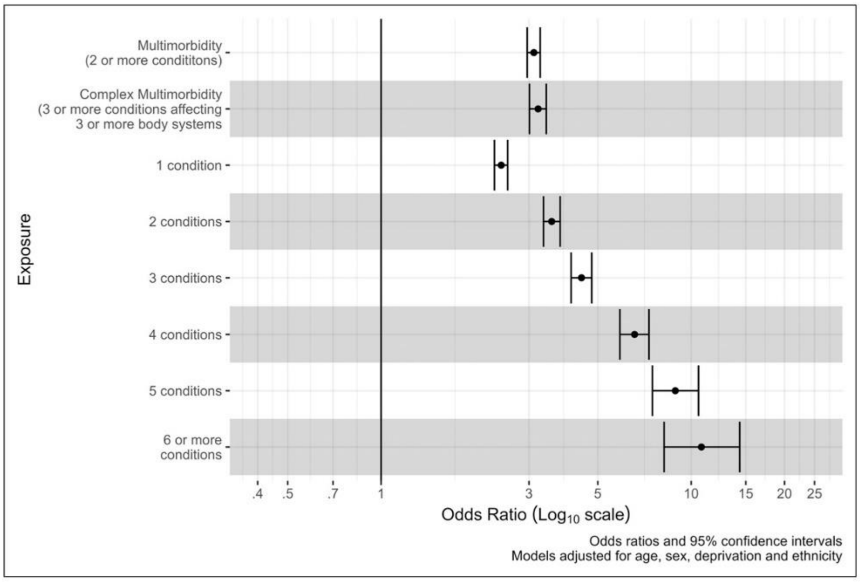

Figure 6. The association between multimorbidity, complex multimorbidity, disease-count and 90-day reattendance: complete case analysis (n=61,241).

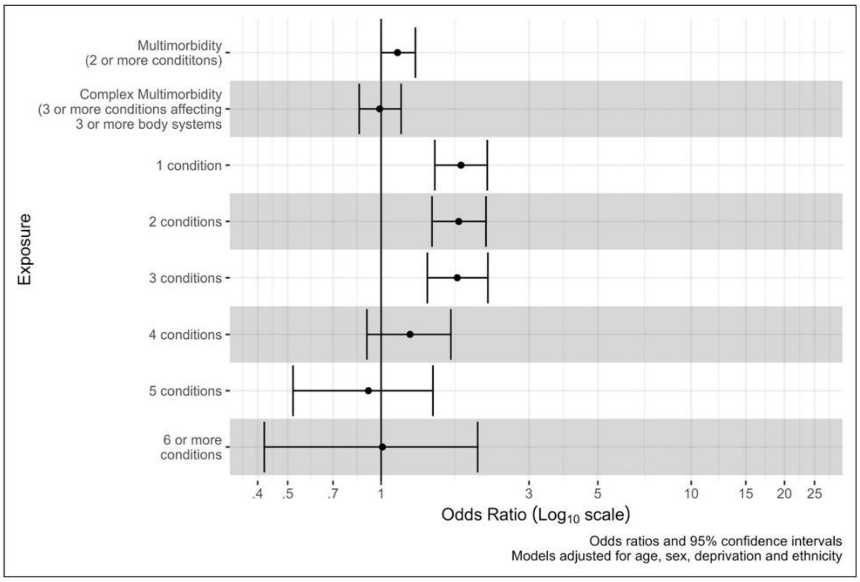

Figure 7. The association between multimorbidity, complex multimorbidity, disease-count and inpatient mortality: complete case analysis (n=27,362).

Table 3. Summary of effect sizes.

		Admission OR (95% CI)	30-day reattendance OR (95% CI)	90-day reattendance OR (95% CI)	Inpatient mortality OR (95% CI)
Multimorbidity	Complete cases	4.15 (3.96–4.35)	2.21 (2.09–2.34)	3.11 (2.96–3.26)	*1.13 p = 0.057* *(1.00–1.29)*
	Imputed data	4.22 (4.03–4.42)	2.18 (2.07–2.31)	3.11 (2.97–3.25)	*0.97 p = 0.743* *(0.83–1.13)*
Complex multimorbidity	Complete cases	3.41 (3.17–3.66)	2.20 (2.04–2.37)	3.21 (3.01–3.41)	*0.99 p = 0.915* *(0.85–1.16)*
	Imputed data	3.45 (3.22–3.70)	2.22 (2.07–2.39)	3.27 (3.08–3.48)	*0.97 p = 0.743* *(0.83–1.13)*
1 condition	Complete cases	5.04 (4.81–5.27)	1.99 (1.87–2.11)	2.44 (2.32–2.56)	1.81 (1.49–2.20)
	Imputed data	5.38 (5.14–5.62)	1.94 (1.83–2.06)	2.41 (2.29–2.53)	1.84 (1.53–2.22)
2 conditions	Complete cases	6.58 (6.19–7.00)	2.55 (2.37–2.75)	3.55 (3.34–3.78)	1.78 (1.46–2.18)
	Imputed data	6.84 (6.45–7.27)	2.48 (2.31–2.66)	3.49 (3.29–3.71)	1.81 (1.49–2.20)
3 conditions	Complete cases	7.15 (6.59–7.77)	2.88 (2.63–3.16)	4.43 (4.10–4.78)	1.76 (1.41–2.21)
	Imputed data	7.27 (6.71–7.89)	2.81 (2.57–3.07)	4.37 (4.05–4.71)	1.77 (1.43–2.20)
4 conditions	Complete cases	7.52 (6.65–8.52)	3.42 (3.02–3.88)	6.57 (5.89–7.31)	*1.24 p = 0.180* *(0.90–1.68)*
	Imputed data	7.62 (6.76–8.60)	3.39 (3.00–3.83)	6.68 (6.01–7.42)	*1.30 p = 0.083* *(0.96–1.74)*
5 conditions	Complete cases	10.03 (8.10–12.54)	4.55 (3.78–5.46)	8.89 (7.50–10.56)	*0.91 p = 0.710* *(0.52–1.47)*
	Imputed data	10.60 (8.60–13.18)	4.51 (3.77–5.37)	8.97 (7.61–10.59)	*0.86 p = 0.557* *(0.50–1.39)*
6+ conditions	Complete cases	14.31 (9.79–21.76)	4.76 (3.54–6.34)	10.79 (8.18–14.34)	*1.01 p = 0.973* *(0.42–2.05)*
	Imputed data	14.04 (9.76–20.91)	4.62 (3.46–6.11)	10.71 (8.18–14.12)	*0.98 p = 0.949* *(0.41–1.96)*

Non-significant findings are italicised.
All models adjusted for age, sex, deprivation and ethnicity.
All $p < 0.001$ except where specified.
No differences were noted in direction of association between complete case and imputed analyses for any combination of exposure and outcome.

misuse (7.2% vs 2.4%), chronic kidney disease (10.9% vs 1.9%), chronic pulmonary disease (8.8% vs 3.2%) and dementia (3.0% vs 0.7%). It is likely that some of this variation can be explained by differences in source data – conditions which drive hospital attendance are more likely to be present in SMR01 data, while primary care data often provides a more reliable record of morbidities – but some differences may still be attributable to population. While primary care services are effective in managing chronic conditions and multimorbidity in the long term, some of the prevalent conditions in this sample (such as alcohol misuse or chronic pulmonary disease) exacerbate rapidly and often unpredictably, and there is a clear need to better understand how multimorbidity presents in the emergency department and the extent to which it is a significant factor in driving healthcare use.

What this reinforces is that multimorbidity patterns and prevalence vary between settings. Interventions to reduce healthcare utilisation or improve quality of care for people with multimorbidity should take this into account and should be localised accordingly. The process of building and training the predictive models which often accompany such interventions should also be undertaken with this in mind. Multimorbidity, complex multimorbidity and disease count are significant factors in risk stratification for this group.

Implications for clinical practice and research

Understanding prospective risk in persons with multimorbidity at the point of presentation to an emergency department may serve clinicians by allowing for the development of risk-stratification tools. Our findings are based on algorithms tested against gold-standard methods of disease identification, and it would be a reasonable assumption that history of these conditions would be elicited by the assessing clinician in the emergency department. Further research is required to validate their use in this population, however. The recent development of the ISARIC 4C score for predicting mortality in hospitalised patients with COVID-19[28] demonstrated the utility of using information available to clinicians at the front-door of the hospital to aid in anticipatory decision-making, and a simple disease-count or binary identification of multimorbidity are easily attainable during assessment. This should be another factor to weigh when making admission and discharge decisions in a time-pressured environment.

The main implication at this point, however, is in developing better predictive models to identify people with multimorbidity who are at risk of these outcomes. Whether these are translated to easy-to-use tools for clinical use in the emergency department, or form the basis of machine-learning solutions to model risk across populations, the use of clinically meaningful data (i.e. diagnoses) will improve the interpretability of such models by clinicians, patients and researchers. The detected associations with negative outcomes in this study suggest that these algorithms can be deployed on relatively short-term data with reasonable sensitivity. Further validation of these algorithms on such short-term data would hopefully support this hypothesis.

Disease-clusters are increasingly the focus of multimorbidity research, although using data to derive latent clusters does not necessarily mean these will be linked to poorer outcomes[20]. The relationship between disease clusters and the outcomes explored here should be investigated further. We also recommend that confounding variables should be expanded to include other variables associated with poor outcomes such as polypharmacy and specific chronic conditions.

Strengths and limitations

This study provides further data on the epidemiology of multimorbidity and 28 important chronic conditions. It has made use of validated algorithms which detect the presence of these conditions with moderate to high accuracy in routinely collected patient data. Rigorous deployment of these algorithms means that comparisons can be made between this and other studies which use these algorithms.

However, this lack of validation on short-term data is the first of some related limitations. The inpatient records available for the purpose of this study dated from 1st July 2017, and to ensure parity between those attending at the start of the year and those attending at the end, we limited the look-back period for the detection of conditions to 21 months. There is a possibility that conditions which were considered permanent or lasted 2-5 years may have been under-detected in this data, were they not coded during any recent admissions. Testing models with more historical admission data would be a possible avenue for further research, as would the incorporation of primary care data. This study has found that multimorbidity and disease-count are significant factors in the prediction of a range of negative outcomes based on relatively short-term historical inpatient data, yet we suspect the true prevalence of chronic illness and multimorbidity in this population may be higher.

Secondly, the algorithm for chronic kidney disease detection was validated also using estimated glomerular filtration rate and urine albumin. Laboratory data were available but local reporting practices meant that the units of measurement were incompatible with the algorithm, and we therefore had to rely on ICD-10 codes only. This again may have led to under-detection, although the rates of chronic kidney disease detected in this study are comparable to those detected using both laboratory and ICD-10 data in a larger study from England[20]. Other minor adjustments to the algorithms were required to ensure compatibility with NHS Scotland data, although we believe the effect of these necessary modifications was negligible.

Some limitations are common to all studies using routinely-collected data as opposed to that which is collected explicitly for the purpose of research. In this case, misclassification bias may be introduced if ICD-10 coding is not comprehensive enough, or when coding is limited by a maximum number of entries. We sought to avert this by using algorithms validated with moderate-to-high accuracy, but this potential risk supports the need to for further validation on data from our population. Additionally, while we sought to control for bias resulting from missing data (through complete case analysis and comparison with imputed data), random forest classification and other types of multiple imputation assume data is missing at random, and this may not have been the case here.

Finally - to satisfy the assumption of independence for logistic regression - we used the first attendance for any individual as the index attendance from which reattendance would be calculated and disregarded any further attendances by the same individual during the 12-month period. This required the removal of 50,435 repeat attendances. In this population as in others, a small minority account for a large proportion of service use[29], and any future predictive modelling would need to factor in the effect of these frequent attenders.

Conclusion

In people attending emergency departments, those with multimorbidity are at an increased risk of admission, reattendance and inpatient mortality compared to those with fewer than two conditions. Multimorbidity, complex multimorbidity and the number of chronic conditions a person has are significantly associated with future healthcare use in this population, therefore clinicians can and should consider the cumulative burden of disease when encountering such patients, not just the conditions which contribute to the immediate presentation. Clinically-observable patterns of multimorbidity can be used to target interventions to improve outcomes. People with multimorbidity are by definition a heterogeneous group, so ensuring risk stratification takes place based on observable findings may improve recognition of those at risk of poorer outcomes.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Data availability

Cohorts and de-identified linked data were prepared by the West of Scotland Safe Haven at NHS Greater Glasgow and Clyde, access to these cohorts and datasets can be obtained via the West of Scotland Safe Haven through their standard governance, ethics and procedures.

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Supplemental Material

Supplemental material for this article is available online.

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Appendix 7

Algorithms for detection of 28 chronic conditions

Condition	Inclusion criteria and duration	ICD codes and exclusions	Notes on application to NHS Scotland data
Alcohol misuse	1 hospitalisation Permanent	E52, F10, G62.1, I42.6,K29.2, K70.0, K70.3, K70.9, T51, Z50.2, Z71.4, Z72.1	Coded across multiple ICD chapters. Assigned to chapter XXI: *Factors influencing health status and contact with health services*
Asthma	1 hospitalisation Permanent	J45	
Atrial fibrillation	1 hospitalisation Permanent	I48.0	
Cancer	1 hospitalisation 5 years	Lymphoma: C81–C85, C88, C90.0, C90.2, C96 Metastatic: C77–C80 Non-metastatic: C18-C21, C33-C34, C38.4, C45.0, C46.71, C50, C53, C61, D01.0-D01.3, D02.2, D05-D06, D07.5	
Chronic heart failure	1 hospitalisation Permanent	I09.9, I25.5, I42.0, I42.5–I42.9, I43, I50	
Chronic kidney disease	1 hospitalisation Permanent	N00-N23	Original algorithms included as an inclusion mean eGFR <60 mL/min*1.73 m2 or mean albuminuria >30 mg/g over 12 months, however eGFR and urine albumin were measured differently in routine laboratory data. We were only able to identify CKD using ICD-10 codes.
Chronic pain	2 hospitalisations 2 years	F45.4, M08.1, M25.50, M25.51, M25.55 - M25.57, M43.2 - M43.6, M45, M46.1, M46.3, M46.4, M46.9, M47, M48.0, M48.1, M48.8, M48.9, M50.8, M50.9, M51, M53.1 - M53.3, M53.8, M53.9, M54, M60.8, M60.9, M63.3, M79.0 - M79.2, M79.6, M79.7, M96.1	Three additional codes were added to this algorithm in an erratum published by Tonelli and colleagues (G89.0, G89.2, G89.4), yet they are not used in NHS Scotland data. Coded across 2 ICD chapters (XIII: *Diseases of the musculoskeletal*

Condition	Inclusion criteria and duration	ICD codes and exclusions	Notes on application to NHS Scotland data
			system and connective tissue, and V: *Mental and behavioural disorders*). Assigned to XIII: *Diseases of the musculoskeletal system and connective tissue*.
Chronic pulmonary disease	1 hospitalisation Permanent	I27.8, I27.9, J40–J44, J46-J47, J60–J67, J68.4, J70.1, J70.3	Coded across 2 ICD chapters (IX: *Diseases of the circulatory system*, and X: *Diseases of the respiratory system*). Assigned to X: *Diseases of the respiratory system*.
Chronic viral hepatitis B	2 hospitalisations Permanent	B16, B18.0-B18.1	
Cirrhosis	1 hospitalisation Permanent	K70.3, K74.3, K74.4, K74.5, K74.6 I85.0, I85.9, I98.2, I98.3, K65.0, K65.8, K65.9, K67.0, K67.1, K67.2, K67.3, K67.8, K76.7, K93.0, R18	
Dementia	1 hospitalisation Permanent	F00–F03, F05.1, G30, G31.1	Coded across 2 ICD chapters (VI: *Diseases of the nervous system*, and V: *Mental and behavioural disorders*). Assigned to VI: *Diseases of the nervous system*.
Depression	1 hospitalisation 2 years	F20.4, F31.3–F31.5, F32, F33, F34.1, F41.2, F43.2	
Diabetes	1 hospitalisation Permanent	E10-E14	
Epilepsy	1 most responsible hospitalisation Permanent	G40-G41	We deemed the mandatory first-entered ICD-10 code (up to six can be entered) to represent the most responsible reason for admission, and only searched within this field.
Hypertension	1 hospitalisation Permanent	I10-I13, I15	
Hypothyroidism	1 hospitalisation Permanent	E00–E03, E89.0	

Condition	Inclusion criteria and duration	ICD codes and exclusions	Notes on application to NHS Scotland data
Inflammatory bowel disease	2 hospitalisations Permanent	K50, K51	
Irritable bowel syndrome	1 hospitalisation Permanent	K58 Exclude: C18-C21, C25, C56, C78.5, C79.6, D01.7, D01.9, D37.1-D37.5, K50-K51, K70.2-K70.3, K74.0, K74.2, K74.6, K86.0-K86.1, K90, K91.2 Excluding surgery during admission	OPCS-4 codes are used to classify interventions and procedures in NHS Scotland data. We excluded any instances where an OPCS-4 code was recorded during admission.
Multiple sclerosis	2 hospitalisations Permanent	G35, G36, G37, H46	Coded across 2 ICD chapters (VI: *Diseases of the nervous system*, and VII: *Diseases of the eye and adnexa*). Assigned to VI: *Diseases of the nervous system*.
Myocardial infarction	1 most responsible hospitalisation Permanent	I21-I22	We deemed the mandatory first-entered ICD-10 code (up to six can be entered) to represent the most responsible reason for admission, and only searched within this field.
Parkinson's disease	1 hospitalisation Permanent	G20, G21, G22	
Peptic ulcer disease	1 hospitalisation 2 years	K25.7, K25.9, K26.7, K26.9, K27.7, K27.9, K28.7, K28.9	
Peripheral vascular disease	1 hospitalisation Permanent	I70.2	
Psoriasis	1 hospitalisation Permanent	L40.0 - L40.4, L40.8, L40.9	
Rheumatoid arthritis	1 hospitalisation Permanent	M05, M06, M31.5, M32–M34, M35.1, M35.3, M36.0	
Schizophrenia	1 hospitalisation Permanent	F20, F21, F23.2, F25	

Condition	Inclusion criteria and duration	ICD codes and exclusions	Notes on application to NHS Scotland data
Severe constipation	1 hospitalisation 2 years	K55.8, K56.0, K56.4, K56.7, K59.0, K63.1, K63.4, K63.81, K63.88, K92.80, K92.88 Exclude: C17-C21, C45.1, C48, C51-C58, C60-C68, C78.5-C78.6, D01.7, D01.9, D37.1-D37.5, K50-K51, K66.0, N73.6, N99.4 (K56.6 if R10.1), and any CCPx surgery listed in claims Excluding surgery during admission	CCPx surgical codes are not used in NHS Scotland data, therefore we utilised the available OPCS-4 codes. OPCS-4 codes are used to classify interventions and procedures in NHS Scotland data. We excluded any instances where an OPCS-4 code was recorded during admission. K63.81 and K63.88 are not used in NHS Scotland data. K63.8 (OTHER SPECIFIED DISEASES OF INTESTINE) was used in their place. K92.80 and K92.88 are not used in NHS Scotland data. K92.8 (OTHER SPECIFIED DISEASES OF DIGESTIVE SYSTEM) was used in their place. These codes accounted for 1.7% of the 355 persons with severe constipation.
Stroke or TIA	1 most responsible hospitalisation Permanent	G45.0-G45.3, G45.8-G45.9, H34.1, I60, I61, I63, I64	We deemed the mandatory first-entered ICD-10 code (up to six can be entered) to represent the most responsible reason for admission, and only searched within this field. Coded across multiple ICD chapters. Assigned to chapter IX: *Diseases of the circulatory system.*

Appendix 8

EMBARQUE Study topic guide

A focussed ethnography of multimorbidity, treatment burden and burden for carers using reflexive qualitative methods (EMBARQUE study)

Interview topic guide

The following topic guide can be used to ensure relevant areas are covered across the series of interviews. **They should not be covered in one study visit,** and some participants may be more focussed/interested in some areas than others. The questions have been developed based on two validated questionnaires designed to assess treatment burden in chronic illness[1] and in multimorbidity[2]. Prompts are *italicised* – these do not need to be asked directly but may be used to elicit further information if necessary.

Questions can be phrased differently dependant on whether they are being directed to the patient or their carer – see comments in **[square brackets].**

Topic 1 - Medicines

1. Can you tell me about the medications **[you/your friend or relative]** take?

   Number of medications?

   Types of medications? (pills, liquids, injections, inhalers, topical)

   Frequency of medications?

   Injections – bruising, bleeding, scars?

   Pills – hard to swallow, taste bad?

2. How do **[you/your friend or relative]** remember to take the right medication at the right time?

   Think about alarms, keeping notes getting others to remind them.

   Missed doses or incorrect doses taken by accident?

3. Are there any special rules **[you/your friend or relative]** need to obey when taking medicines?

   Need to eat/fast?

   Need to lie down, get undressed to apply topical drugs?

4. Do **[you/your friend or relative]** collect **[your/their]** own medicines/prescriptions?

   *If not, do **[you/they]** arrange someone else to do it? Pay someone else to do it?*

   *If not, do **[you/they]** have to make phone calls, go online etc to organise?*

Topic 2 – Self-management activities

5. Do **[you/your friend or relative]** have to do anything to monitor **[your/their]** conditions?

Blood sugar? Blood pressure? SpO2?

Symptoms?

*If any equipment is used – how do **[you/they]** maintain it?*

6. Have **[you/your friend or relative]** had to make any changes to the way **[you/they]** eat or exercise because of health conditions?

Had to lose weight or restrict certain foods?

Had to gain weight or include certain foods?

Had to increase exercise or undertake certain exercises, including physical therapy?

Had to abstain from types of exercise which were previously undertaken?

7. How do **[you/your friend or relative]** keep informed about the chronic conditions **[you/they]** have?

Any formal patient education?

Education delivered by informal carers?

Self-directed research and education?

Topic 3 - Accessing health care

8. What health professionals do **[you/your friend or relative]** see for **[your/their]** conditions?

What specialists in particular, and how often?

Are they in different places?

Are they all on different days?

9. How do **[you/your friend or relative]** get to appointments?

Driving or getting public transport?

Are they far away or far apart if on the same day?

Getting informal or NHS transport?

10. Do appointments take a long time?

Long wait times in clinics?

Gaps between appointments if on same day?

Waiting for transport?

11. How do **[you/your friend or relative]** arrange and keep track of appointments?

*Do **[you/they]** arrange your [their] own appointments or are they sent to you [them]?*

*Do **[you/they]** have to get someone else to help arrange appointments?*

*Do **[you/they]** get reminders of appointments?*

*Do **[you/they]** have to keep a diary?*

*Do **[you/they]** have to get time off work or other commitments?*

12. Do **[you/your friend or relative]** have to arrange any other types of care or support?

Paid or informal carers?

District nurses?

Community support?

13. Do **[you/your friend or relative]** ever get conflicts with appointments being booked together?

Appointments booked on the same day?

*How do **[you/they]** resolve these conflicts?*

14. Do **[you/your friend or relative]** ever have to access emergency or out-of-hours care?

Time spent, travelling, arranging carers as above

15. Do **[you/your friend or relative] have** to pay for anything that helps **[you/them]** manage **[your/their]** conditions?

Non-prescription medications?

Adaptions to home environment?

Carers (including informal)?

Travel?

Loss of work?

16. Is there any paperwork or administrative work **[you/your friend or relative]** have to do because of **[your/their]** conditions?

Applications for support related to treatment

Anything related to employment

Reimbursement for costs incurred (travel etc).

Topic 4 – Social and personal

17. Can you tell me about any help **[you/your friend or relative]** get from family or friends to manage **[your/their]** conditions?

Recap anything which has been mentioned up till now

*Do **[you/they]** have to organise and manage this support?*

18. Has **[your/your friend or relative's]** healthcare had any impact on **[your/their]** social relationships?

This may be positive or negative

Don't just focus on immediate caregivers – has it affected friendships or work relationships?

19. Does the healthcare **[you/your friend or relative]** use have any impact on the way **[you/they]** feel about [**yourself/themselves]**?

Use example of 'frequent healthcare reminds me of my health problems' – a theme identified by UK participants in the development of the treatment burden questionnaire

Topic 5 – COVID-specific impact

20. Did the way **[you/your friend or relative]** access healthcare change during the coronavirus pandemic?

Remote appointments?

Fewer appointments?

Same contact with carers and community services?

21. Were there any positive aspects to these changes?

*Did these reduce treatment burden in any way, and is there anything which **[you/they]** would like to continue if given the choice?*

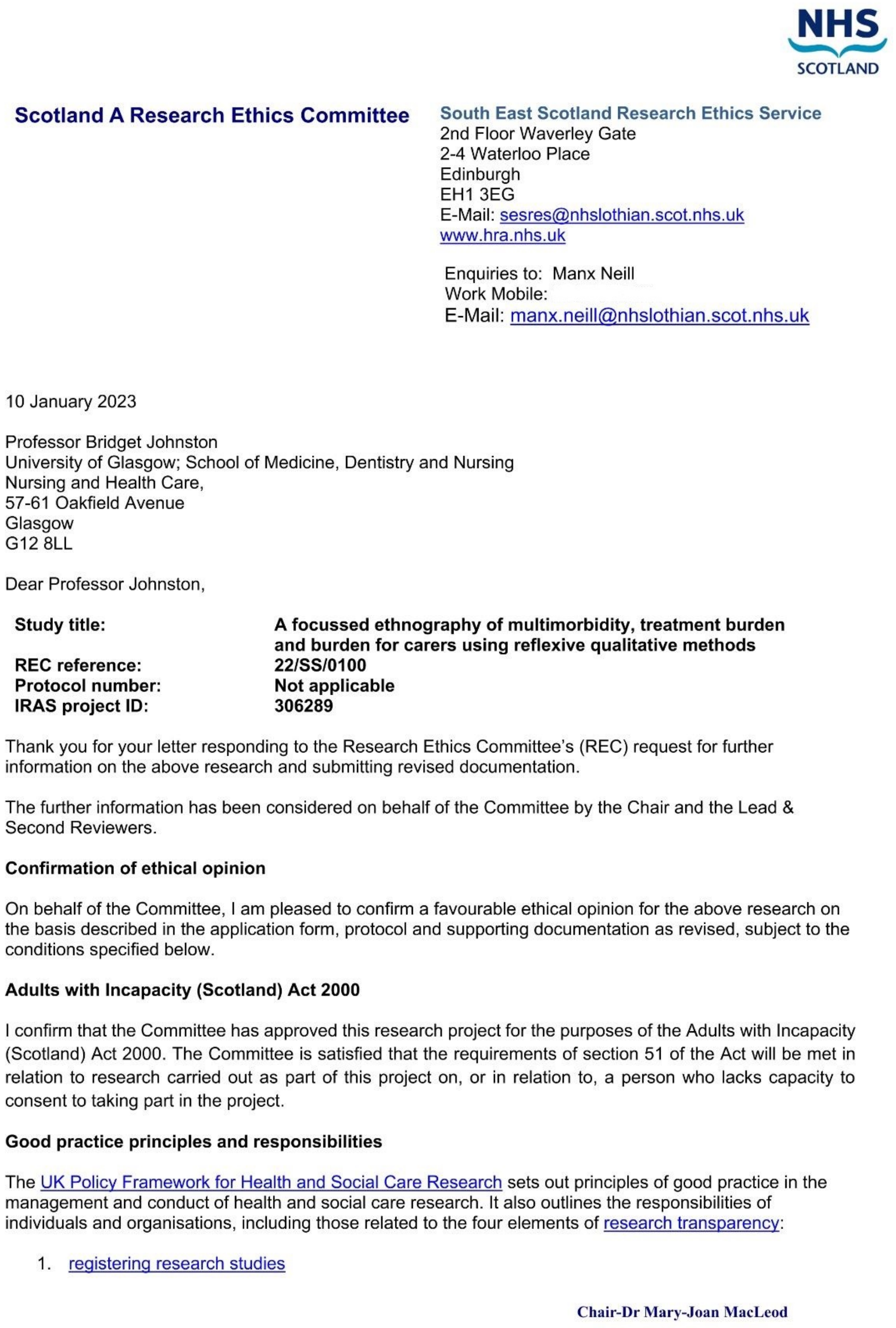
References

1. Tran V-T, Harrington M, Montori VM, et al. Adaptation and validation of the Treatment Burden Questionnaire (TBQ) in English using an internet platform. *BMC Medicine* 2014;12(1):109. doi: 10.1186/1741-7015-12-109

2. Duncan P, Murphy M, Man MS, et al. Development and validation of the Multimorbidity Treatment Burden Questionnaire (MTBQ). *BMJ Open* 2018;8(4):e019413. doi: 10.1136/bmjopen-2017-019413 [published Online First: 2018/04/15]

Appendix 9

Favourable opinion letter from Scotland REC A



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10 January 2023

Professor Bridget Johnston
University of Glasgow; School of Medicine, Dentistry and Nursing
Nursing and Health Care,
57-61 Oakfield Avenue
Glasgow
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Dear Professor Johnston,

Study title:	**A focussed ethnography of multimorbidity, treatment burden and burden for carers using reflexive qualitative methods**
REC reference:	**22/SS/0100**
Protocol number:	**Not applicable**
IRAS project ID:	**306289**

Thank you for your letter responding to the Research Ethics Committee's (REC) request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair and the Lead & Second Reviewers.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Adults with Incapacity (Scotland) Act 2000

I confirm that the Committee has approved this research project for the purposes of the Adults with Incapacity (Scotland) Act 2000. The Committee is satisfied that the requirements of section 51 of the Act will be met in relation to research carried out as part of this project on, or in relation to, a person who lacks capacity to consent to taking part in the project.

Good practice principles and responsibilities

The UK Policy Framework for Health and Social Care Research sets out principles of good practice in the management and conduct of health and social care research. It also outlines the responsibilities of individuals and organisations, including those related to the four elements of research transparency:

1. registering research studies

2. reporting results
3. informing participants
4. sharing study data and tissue

Conditions of the favourable opinion

The REC favourable opinion is subject to the following conditions being met prior to the start of the study.

Confirmation of Capacity and Capability (in England, Northern Ireland and Wales) or NHS management permission (in Scotland) should be sought from all NHS organisations involved in the study in accordance with NHS research governance arrangements. Each NHS organisation must confirm through the signing of agreements and/or other documents that it has given permission for the research to proceed (except where explicitly specified otherwise).

Guidance on applying for HRA and HCRW Approval (England and Wales)/ NHS permission for research is available in the Integrated Research Application System.

For non-NHS sites, site management permission should be obtained in accordance with the procedures of the relevant host organisation.

Sponsors are not required to notify the Committee of management permissions from host organisations

Registration of Clinical Trials

All research should be registered in a publicly accessible database and we expect all researchers, research sponsors and others to meet this fundamental best practice standard.

It is a condition of the REC favourable opinion that **all clinical trials are registered** on a publicly accessible database within six weeks of recruiting the first research participant. For this purpose, 'clinical trials' are defined as:

- clinical trial of an investigational medicinal product
- clinical investigation or other study of a medical device
- combined trial of an investigational medicinal product and an investigational medical device
- other clinical trial to study a novel intervention or randomised clinical trial to compare interventions in clinical practice.

Failure to register a clinical trial is a breach of these approval conditions, unless a deferral has been agreed by the HRA (for more information on registration and requesting a deferral see: Research registration and research project identifiers).

If you have not already included registration details in your IRAS application form you should notify the REC of the registration details as soon as possible.

Publication of Your Research Summary

We will publish your research summary for the above study on the research summaries section of our website, together with your contact details, no earlier than three months from the date of this favourable opinion letter.

Should you wish to provide a substitute contact point, make a request to defer, or require further information, please visit: https://www.hra.nhs.uk/planning-and-improving-research/application-summaries/research-summaries/

N.B. If your study is related to COVID-19 we will aim to publish your research summary within 3 days rather than three months.

During this public health emergency, it is vital that everyone can promptly identify all relevant research related to COVID-19 that is taking place globally. If you haven't already done so, please register your study on a public registry as soon as possible and provide the REC with the registration detail, which will be posted alongside other information relating to your project. We are also asking sponsors not to request deferral of publication of research summary for any projects relating to COVID-19. In addition, to facilitate finding and extracting studies related to COVID-19 from public databases, please enter the WHO official acronym for the coronavirus disease (COVID-19) in the full title of your study. Approved COVID-19 studies can be found at: https://www.hra.nhs.uk/covid-19-research/approved-covid-19-research/

It is the responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).

After ethical review: Reporting requirements

The attached document "After ethical review – guidance for researchers" gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Adding new sites and investigators
- Notification of serious breaches of the protocol
- Progress and safety reports
- Notifying the end of the study, including early termination of the study
- Final report
- Reporting results

The latest guidance on these topics can be found at https://www.hra.nhs.uk/approvals-amendments/managing-your-approval/.

Ethical review of research sites

NHS/HSC sites

The favourable opinion applies to all NHS/HSC sites taking part in the study, subject to confirmation of Capacity and Capability (in England, Northern Ireland and Wales) or management permission (in Scotland) being obtained from the NHS/HSC R&D office prior to the start of the study (see "Conditions of the favourable opinion" below).

Non-NHS/HSC sites

I am pleased to confirm that the favourable opinion applies to any non-NHS/HSC sites listed in the application, subject to site management permission being obtained prior to the start of the study at the site.

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document	*Version*	*Date*
Copies of materials calling attention of potential participants to the research [Recruitment flyer]	1.3	27 September 2022
Covering letter on headed paper [Cover letter]	1.0	07 October 2022
Covering letter on headed paper [Cover letter]	1.2	16 December 2022
Evidence of Sponsor insurance or indemnity (non NHS Sponsors only) [University of Glasgow Insurance Certificate]		

GP/consultant information sheets or letters [Clinician information slides]	1.2	27 September 2022
Interview schedules or topic guides for participants [Interview topic guide]	1.1	19 August 2022
IRAS Application Form [IRAS_Form_07102022]		07 October 2022
Non-validated questionnaire [Screening proforma]	1.4	05 October 2022
Non-validated questionnaire [AWI screening proforma]	1.4	05 October 2022
Other [NHSGGC lone worker policy]	3.0	01 December 2021
Other [University of Glasgow lone activity procedure]		01 May 2022
Other [EDGE minimum dataset (guideline)]	1.0	22 June 2018
Other [Table of responses to provisional opinion from REC]	1.1	16 December 2022
Participant consent form [Consent form (clean version)]	1.6	16 December 2022
Participant consent form [Consent form (tracked version)]	1.6	16 December 2022
Participant consent form [Consent form for carers (clean version)]	1.4	16 December 2022
Participant consent form [Consent form for carers (tracked version)]	1.4	16 December 2022
Participant consent form [Consent form for legal representatives (clean version)]	1.6	16 December 2022
Participant consent form [Consent form for legal representatives (tracked version)]	1.6	16 December 2022
Participant consent form [Consent form for recovered capacity (clean version)]	1.4	16 December 2022
Participant consent form [Consent form for recovered capacity (tracked version)]	1.4	16 December 2022
Participant information sheet (PIS) [Journal instructions]	1.3	05 October 2022
Participant information sheet (PIS) [Signposting sheet]	1.0	19 August 2022
Participant information sheet (PIS) [Participant information leaflet for patients (clean version)]	1.4	12 December 2022
Participant information sheet (PIS) [Participant information leaflet for patients (tracked version)]	1.4	12 December 2022
Participant information sheet (PIS) [Participant information leaflet for carers (clean version)]	1.4	12 December 2022
Participant information sheet (PIS) [Participant information leaflet for carers (tracked version)]	1.4	12 December 2022
Participant information sheet (PIS) [Participant information leaflet for legal representatives (clean version)]	1.5	12 December 2022
Participant information sheet (PIS) [Participant information leaflet for legal representatives (tracked version)]	1.5	12 December 2022
Participant information sheet (PIS) [Participant information leaflet for recovered capacity (clean version)]	1.3	12 December 2022
Participant information sheet (PIS) [Participant information leaflet for recovered capacity (tracked version)]	1.3	12 December 2022
Research protocol or project proposal [EMBARQUE Protocol]	1.5	05 October 2022
Summary CV for Chief Investigator (CI) [Professor Bridget Johnston's CV]		22 July 2022
Summary CV for student [Chris McParland CV]	1.0	22 July 2022
Summary CV for supervisor (student research) [Dr Mark Cooper CV]		22 July 2022

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

User Feedback

The Health Research Authority is continually striving to provide a high quality service to all applicants and sponsors. You are invited to give your view of the service you have received and the application procedure. If you wish to make your views known please use the feedback form available on the HRA website: http://www.hra.nhs.uk/about-the-hra/governance/quality-assurance/

HRA Learning

We are pleased to welcome researchers and research staff to our HRA Learning Events and online learning opportunities– see details at: https://www.hra.nhs.uk/planning-and-improving-research/learning/

IRAS project ID: 306289 Please quote this number on all correspondence

With the Committee's best wishes for the success of this project.

Yours sincerely

Dr Mary-Joan Macleod
Chair

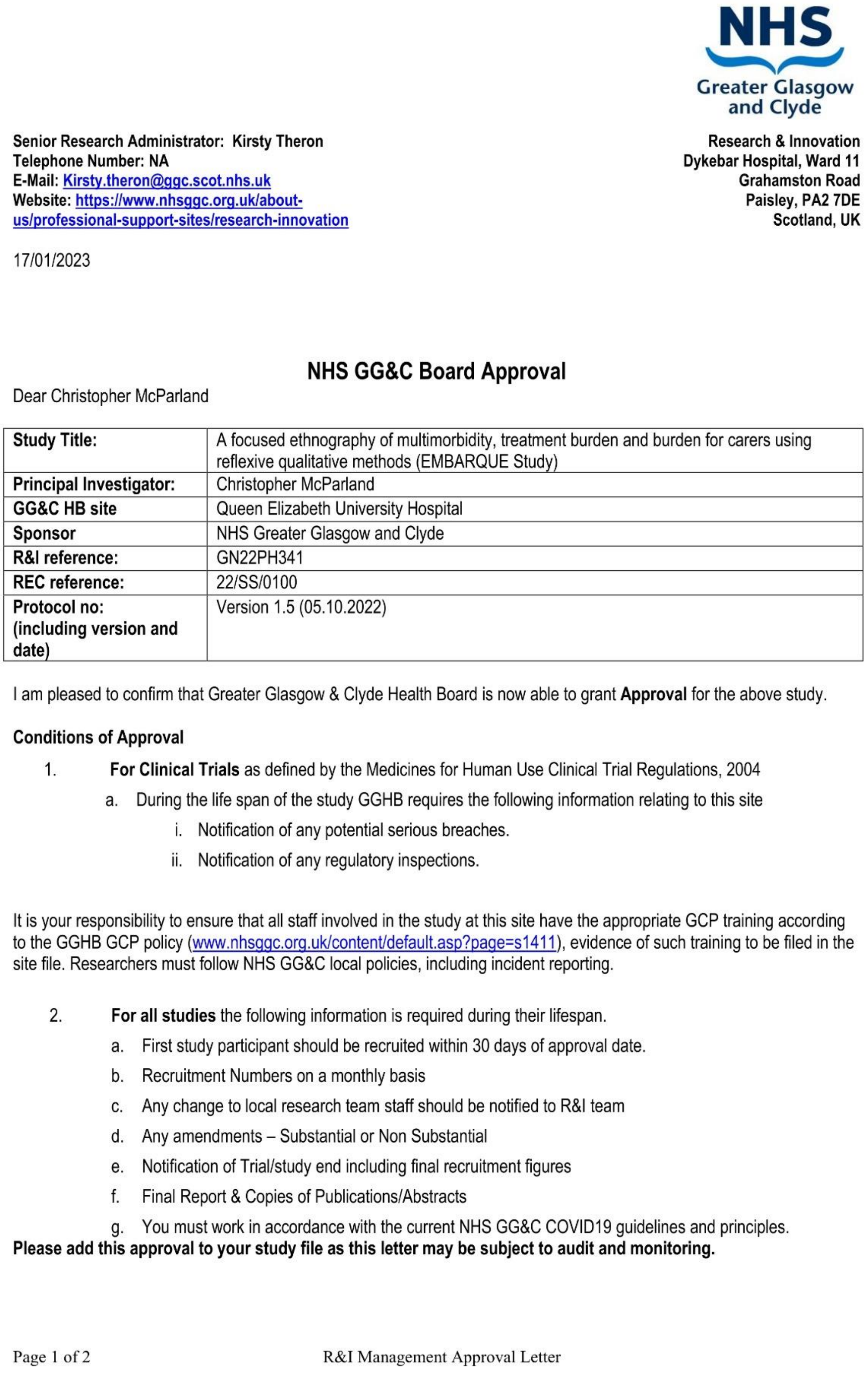
Email: Manx.Neill@nhslothian.scot.nhs.uk

Enclosures: "After ethical review – guidance for researchers" *[SL-AR2]*

Copy to: Dr Colette Montgomery Sardar
Lead Nation: Scotland: gram.nrspcc@nhs.scot

Appendix 10

Approval letter from NHSGGC R&I



NHS
Greater Glasgow and Clyde

Senior Research Administrator: Kirsty Theron
Telephone Number: NA
E-Mail: Kirsty.theron@ggc.scot.nhs.uk
Website: https://www.nhsggc.org.uk/about-us/professional-support-sites/research-innovation

Research & Innovation
Dykebar Hospital, Ward 11
Grahamston Road
Paisley, PA2 7DE
Scotland, UK

17/01/2023

NHS GG&C Board Approval

Dear Christopher McParland

Study Title:	A focused ethnography of multimorbidity, treatment burden and burden for carers using reflexive qualitative methods (EMBARQUE Study)
Principal Investigator:	Christopher McParland
GG&C HB site	Queen Elizabeth University Hospital
Sponsor	NHS Greater Glasgow and Clyde
R&I reference:	GN22PH341
REC reference:	22/SS/0100
Protocol no: (including version and date)	Version 1.5 (05.10.2022)

I am pleased to confirm that Greater Glasgow & Clyde Health Board is now able to grant **Approval** for the above study.

Conditions of Approval

1. **For Clinical Trials** as defined by the Medicines for Human Use Clinical Trial Regulations, 2004
    a. During the life span of the study GGHB requires the following information relating to this site
        i. Notification of any potential serious breaches.
        ii. Notification of any regulatory inspections.

It is your responsibility to ensure that all staff involved in the study at this site have the appropriate GCP training according to the GGHB GCP policy (www.nhsggc.org.uk/content/default.asp?page=s1411), evidence of such training to be filed in the site file. Researchers must follow NHS GG&C local policies, including incident reporting.

2. **For all studies** the following information is required during their lifespan.
    a. First study participant should be recruited within 30 days of approval date.
    b. Recruitment Numbers on a monthly basis
    c. Any change to local research team staff should be notified to R&I team
    d. Any amendments – Substantial or Non Substantial
    e. Notification of Trial/study end including final recruitment figures
    f. Final Report & Copies of Publications/Abstracts
    g. You must work in accordance with the current NHS GG&C COVID19 guidelines and principles.

Please add this approval to your study file as this letter may be subject to audit and monitoring.

NHS
Greater Glasgow
and Clyde

Your personal information will be held on a secure national web-based NHS database.

I wish you every success with this research study

Yours sincerely,

Kirsty Theron
Senior Research Administrator

CC: C Montgomery Sardar

Appendix 11

Summary table of studies included in systematic review

Study, location and report(s) cited†	Design	Participants	Summary quality score‡	Intervention	Summary of key findings [outcome measure] §
Boyd et al, 2008 **USA** **(Boyd et al., 2008)** **(Sylvia et al., 2008)**	Controlled (quasi-experimental) clinical trial (pilot)	150 (75 intervention, 75 control) Age >65, multimorbid population identified using predictive modelling	67%	Guided Care Primary care nurse case management intervention. Pilot tested 6 of 8 components.	**Quality of healthcare - mixed** No significant improvement in any domain of patient satisfaction [PACIC] in intention to treat and per-protocol analyses. One domain (communication) significant improvement in regression model **Costs - mixed** Possible lower healthcare expenditure for Guided Care patients at lower risk of healthcare utilisation.

Study, location and report(s) cited†	Design	Participants	Summary quality score‡	Intervention	Summary of key findings [outcome measure] §
Boult et al, 2011 **USA** **(Boult et al., 2008)** **(Leff et al., 2009)** **(Boyd et al., 2010)** **(Boult et al., 2011)**	Cluster randomised controlled trial	904 (485 intervention, 419 control) Age >65, multimorbid population identified using predictive modelling	77%	Guided Care Primary care nurse case management intervention.	**Quality of healthcare - mostly improved** Small but significant improvement in overall patient satisfaction [PACIC] Some aspects of physician satisfaction improved but mostly unaffected [PCAT] 6/7 GC nurses moderately/very satisfied with role. **Healthcare use - mostly unaffected** GC did not reduce emergency, secondary care, primary care or skilled nursing facility usage. Reduced home healthcare episodes. **Costs - mostly unaffected** No significant reduction in costs for GC patients

Study, location and report(s) cited†	Design	Participants	Summary quality score‡	Intervention	Summary of key findings [outcome measure] §
Chow & Wong, 2014 Hong Kong (Chow and Wong, 2014)	Randomised controlled trial (3 arms)	281 (98 control, 87 home visit arm, 96 phone arm) Age >65, 2 or more conditions and admitting diagnosis of chronic respiratory disease, cardiac disease, T2DM or renal disease.	85%	Transitional care intervention for hospital discharged adults. Delivered by advanced practice nurses and nursing students. One arm received home visits and telephone calls, one arm received telephone calls only.	**Healthcare use - mixed** Readmission rates reduced at 84 days post-discharge in both intervention arms vs control, significant in phone arm vs control. No significant improvement in readmission at 28 days. **Health related quality of life - mixed** Physical component of [SF-36] higher in intervention arms at baseline, 28 and 84 days. No significant difference in mental component [SF-36] **Self-efficacy - mostly improved** Both intervention arms had higher self-efficacy across all three timepoints compared to control [Short-form Chronic Disease Self-efficacy scale] **Self-rated health - mostly improved** Evidence of improvement in self-rated health in intervention groups at 28 and 84 days [Likert-type scale]

Study, location and report(s) cited†	Design	Participants	Summary quality score‡	Intervention	Summary of key findings [outcome measure] §
Dorr et al, 2008 **USA** **(Dorr et al., 2008)**	Controlled (quasi-experimental) clinical trial	3,432 (1,144 intervention, 2,288 control) Age ≥65, complexity including multimorbidity referring criteria	89%	Intermountain nurse case management intervention (primary care based)	**Mortality - mixed** Deaths were lower in intervention group at 1 year, no difference by 2 years. **Healthcare use - mostly unaffected** No significant improvement in hospitalisation and ED use were detected. Improvements were noted across outcomes in a diabetes subgroup.

Study, location and report(s) cited†	Design	Participants	Summary quality score‡	Intervention	Summary of key findings [outcome measure] §
Doyle et al, 2022 Belgium & Ireland (Doyle et al., 2022)	Qualitative (descriptive/ exploratory)	119 people with multimorbidity (≥2 conditions), 10 nurses involved in intervention.	70%	ICT intervention comprising remote monitoring and telemedicine provided by triage nurse.	**Self-management behaviour - mostly improved** Qualitative evidence that automated alerts for physiological parameters being exceeded became less frequent over time - attributed to self-management. **Self-efficacy - mostly improved** Confidence in ability to achieve health outcomes improved due to intervention. **Quality of healthcare - mostly improved** Patients felt safe because they were being monitored comprehensively. **Case-finding and referrals - mostly improved** Referral for interventions or specialist review increased during the intervention **Treatment burden - mostly unaffected** Some participants found the intervention and frequency of contact to be burdensome.

Study, location and report(s) cited†	Design	Participants	Summary quality score‡	Intervention	Summary of key findings [outcome measure] §
Gabbard et al, 2021 **USA** **(Gabbard et al., 2021)**	Randomised controlled trial	759 (379 intervention, 380 control), age ≥65, Charlson Comorbidity Index ≥3 with physical or cognitive impairment and/or frailty.	77%	Nurse navigator-led intervention to encourage anticipatory care planning.	**Anticipatory care planning - mostly improved** Intervention increased levels of anticipatory care plans made, advanced directives, surrogate decision makers appointed and billing for anticipatory care plan discussion. **Health care use - mostly unaffected** No immediate significant reduction in health care use as a result of intervention, some evidence to suggest reduction after 1 year.

Study, location and report(s) cited†	Design	Participants	Summary quality score‡	Intervention	Summary of key findings [outcome measure] §
Garcia-Fernandez et al, 2014 Spain **(García-Fernández et al., 2014)**	Retrospective analytical cohort study	255 (62 intervention, 193 control) Age ≥18, requirement that participants were complex including >2 diseases	55%	Hospital-based nurse case manager	**Mortality - mostly unaffected** No difference between groups in mortality at 90 days **Healthcare use - mostly unaffected** Non-significant difference between groups in readmission or resource utilisation at 90 days **Activities of daily living - mostly improved** Intervention group had stable [Barthel index] score while control group declined **Quality of healthcare - mostly improved** Satisfaction with care and care continuity was higher in the case-managed group at 90 days **Caregiver support - mixed** [Caregiver Burden Index] remained stable in intervention group while control declined. No differences detected in [Caregiver Preparation Index]

Study, location and report(s) cited†	Design	Participants	Summary quality score‡	Intervention	Summary of key findings [outcome measure] §
Hanson et al, 2018 **USA** **(Takahashi et al., 2016) (Hanson et al., 2018)**	Retrospective analytical cohort study	730 (365 intervention and 365 propensity-matched cohort) Age ≥60, multimorbid population identified using predictive modelling	100%	Mayo Clinic Care Transitions programme. Advanced practice nurse transitional care intervention	**Mortality - mixed** Significant reduction in mortality for intervention group at 30 days, not sustained at 90 or 180 days **Healthcare use - mixed** Significant reduction in readmissions and readmission/ED visits for the intervention at 30 days, not sustained at 90 or 180 days. No differences in bed days, ICU days, ED visits at any timepoint. **Costs - mixed** No significant reductions in costs for intervention group at 30 or 90 days. Further analysis revealed significant reduction at 30 days for the 80th percentile risk group at 30 days.

Study, location and report(s) cited†	Design	Participants	Summary quality score‡	Intervention	Summary of key findings [outcome measure] §
Hjelm et al, 2015 **Sweden** **(Gustafsson et al., 2013)** (Hjelm et al., 2015)	Qualitative (focussed ethnography)	9 case managers (8 were nurses) 13 older (>75) people with multimorbidity (≥3 conditions and ≥3 hospital admissions in last year)	90%	Blekinge case management intervention Operates from outside healthcare system, CMs are non-clinical	**Quality of healthcare - mostly improved** Several illustrations highlighting how patients appreciated the CMs ability to develop therapeutic relationships with those in their care **Trust and advocacy - mostly improved** Several illustration highlighting that the CMs were trusted by patients and appreciated for their role in advocating for the patient
Hummel et al, 2017 **USA** **(Hummel et al., 2017)**	Retrospective analytical cohort study	82 (19 intervention, 63 control) Veterans Health Association patients, multimorbid population identified using predictive modelling	55%	Intensive Management Patient Aligned Care Team (imPACT) Nurse practitioner led interdisciplinary intervention, compared with physician-led PACT	**Proactive case finding - mixed** The imPACT patients had significantly greater referrals to hospice, suggesting better identification of palliative care needs. This was no longer significant in sensitivity analysis which removed people with cancer and dementia.

Study, location and report(s) cited†	Design	Participants	Summary quality score‡	Intervention	Summary of key findings [outcome measure] §
Jackson et al, 2016 **USA** **(Jackson et al., 2016)**	Retrospective analytical cohort study	35,174 (7,468 intervention, 27,706 control). No age restriction, multimorbid population identified using predictive modelling	91%	Nurse home visits in addition to an existing transitional care intervention, compared to transitional care intervention without home visit	**Healthcare use - mostly improved** Home visits generated strong reduction in 30-day readmission and reduced 6-month inpatient admission in 4 of 6 subgroups stratified by risk. **Costs - mixed** 6-month inpatient costs were reduced in the highest risk strata but were unaffected in the remaining five subgroups.
Karlsson & Karlsson, 2019 Sweden **(Karlsson and Karlsson, 2019)**	Qualitative (descriptive/ exploratory)	10 nurses providing home visits to people aged ≥65 with multimorbidity	50%	Follow-up 48-72 transitional care intervention. Nurse home-visits post-hospital discharge	**Quality of healthcare - mostly improved** Some illustration of nurses improving satisfaction with healthcare by answering questions/ relieving anxieties at home visit **Communication - mostly improved** Some illustration to suggest face-to-face visit improves ability to assess patients holistically
Lowe et al, 2022 **Australia** **(Lowe et al., 2022)**	Pre/post test (quasi-experimental) study (pilot)	77 people aged ≥65 with ≥2 conditions	44%	Nurse practitioner-led case management intervention intended to improve access to healthcare and reduce re-admissions	**Healthcare use - mostly improved** Post intervention reductions in emergency department and outpatient service use, and admissions.

Lupari, 2011 UK, Northern Ireland **(Lupari, 2011)**	Mixed-methods: controlled (quasi-experimental) clinical trial/ qualitative descriptive	590 (295 intervention, 295 control) Age>65, multimorbid population identified using predictive modelling	Quant: 89% Qual: 90%	Community-based nurse case management intervention	**Health related quality of life - mostly improved** Health related quality of life improved across the three timepoints (12,24,36 months) for the intervention, control declined [EQ-5D + VAS] **Healthcare use - mostly improved** Bed days significantly reduced at all timepoints apart from 24 weeks. Hospitalisation significantly reduced at 36 weeks but not 12 or 24. **Costs - mostly improved** Intervention group demonstrated a significant increase in QALYs at 9-months **Physical function - mostly improved** Function improved in the intervention group across the three time points while control declined [FIM/FAM] **Caregiver support - mixed** There was no significant difference between groups in caregiver strain [Caregiver Strain Index], however qualitative illustrations suggested

Study, location and report(s) cited†	Design	Participants	Summary quality score‡	Intervention	Summary of key findings [outcome measure] §
					carers were supportive of intervention
Mallow et al, 2018 **USA** **(Mallow et al., 2018)**	Pre/post test (quasi-experimental) study	30. Age ≥18, requires combination of chronic diseases and biopsychosocial risk factors (low income, uninsured, poor access to healthcare)	44%	mI SMART web application and telehealth intervention delivered by nurse practitioner	**Physiological measures - mostly improved** The mI SMART intervention was associated with significant improvements in blood pressure and glycaemic control, but only borderline significant weight reductions

Study, location and report(s) cited†	Design	Participants	Summary quality score‡	Intervention	Summary of key findings [outcome measure] §
Markle-Reid et al, 2016 Canada (Markle-Reid et al., 2016)	Pre/post test (quasi-experimental) study (pilot)	45 (37 completed follow-up) Age ≥65, requires diagnosis of diabetes and multimorbidity (≥2 other conditions)	78%	Aging, Community and Health Research Unit Community Partnership Program (ACHRU-CPP) Nurse-led interdisciplinary intervention to support self-management.	**Mental health - mostly unaffected** No significant differences in depressive symptoms [CES-D] or anxiety [GAD-7] **Health related quality of life - mixed** Small significant improvement in physical component of [SF-12], no improvement in mental component **Costs - mixed** Small cost reductions in some areas of healthcare offset an increase in the cost of diabetes care **Self-management behaviour - mostly unaffected** No improvements detected in diabetes self-care [Diabetes Self Care Activity Scale]

Markle-Reid et al, 2020 **Canada** **(Markle-Reid et al., 2018) (Miklavcic et al., 2020)**	Randomised controlled trial	2 sites: Ontario: 159 (80 intervention, 79 control) Alberta: 132 (70 intervention, 62 control) Age ≥65, requires diagnosis of diabetes and multimorbidity (≥2 other conditions)	77%	Aging, Community and Health Research Unit Community Partnership Program (ACHRU-CPP) Nurse-led interdisciplinary intervention to support self-management.	**Mental health - mixed** Difference in depression [CES-D-10] favouring the intervention group in Ontario. No difference for depression in Alberta. Anxiety [GAD-7] unaffected at both sites. **Health related quality of life - mixed** The mental component score of [SF-12] was higher in the Ontario intervention group. There was no difference in mental component score in Alberta, and there was no difference in physical component score at either site. **Costs - mostly improved** At both sites, small reductions in costs across healthcare services were offset by an increase in diabetes related costs, indicating cost-neutrality. **Self-management behaviour - mixed** There was a small significant improvement in diabetes self-management in Ontario. No difference was detected in Alberta [Summary of Diabetes Self-Care Activities]

Study, location and report(s) cited†	Design	Participants	Summary quality score‡	Intervention	Summary of key findings [outcome measure] §
					Self-efficacy - mostly unaffected No significant difference was detected in self-efficacy at either site [Self Efficacy for Managing Chronic Disease Scale]

Markle-Reid at al, 2021 Canada (Markle-Reid et al., 2021)	Randomised controlled trial	127 (63 intervention, 64 control) people aged ≥65 with ≥2 chronic conditions and depressive symptoms	77%	6-month transitional care intervention delivered by registered nurses	**Communication - mixed** Some evidence that information from HCPs improved for the intervention group but no other domain of the [Client Centred Care Questionnaire] and [Intermediate Care for Older People Home-Based-Integrated Care Patient-Reported Experience Measures] **Mental health - mostly unaffected** No significant improvement in mental health and depressive symptoms measured using the [Mental Component Score score from the Veterans Rand 12-item health survey (VR-12)], the [Centre for Epidemiologic Studies Depression Scale 10-item tool (CESD-10)] or the [Generalized Anxiety Disorder 7-item scale (GAD-7)]. **Health care use - mostly unaffected** No significant reductions in health care utilisation, measured with the [Health and Social Services Utilization Inventory (HSSUI)].

Study, location and report(s) cited†	Design	Participants	Summary quality score‡	Intervention	Summary of key findings [outcome measure] §
					Physical function - mostly unaffected No significant improvement in physical function measured using the [Physical Component Score from VR-12].

Study, location and report(s) cited†	Design	Participants	Summary quality score‡	Intervention	Summary of key findings [outcome measure] §
Mesa-Melgarejo et al, 2022 **Colombia** **(Mesa-Melgarejo et al., 2022)**	Mixed-methods: pre/post test (quasi-experimental) study, with qualitative descriptive/ exploratory interviews	Quantitative: 317 people with ≥2 conditions and medium/high levels of complexity Qualitative: 17 patient/carer dyads (n=34) and 6 nurses	Quant: 67% Qual: 50%	Nurse-led case management involving case-finding, comprehensive assessment and individualised care planning/follow-up	Qualitative findings were used to triangulate quantitative findings. **Health care use - mixed** Reductions in primary and specialised care consultations, but no improvement in emergency care, admissions, bed-days and dispensed medications. **Activities of daily living - mostly improved** Significant improvements noted in independence using [Barthel index] but not the [Instrumental Activities of Daily Living scale (Lawton and Brody)]. **Caregiver support - mostly improved** Overall improvements noted in caregiver burden and support measured using [Zarit score]. **Health related quality of life - mixed** Improvements noted in some [SF-36] domains (role limitations, pain, social role and mental health) but not others (general health, energy/vitality, health transition).

Study, location and report(s) cited†	Design	Participants	Summary quality score‡	Intervention	Summary of key findings [outcome measure] §
Moran et al, 2008 **UK, Wales** **(Moran et al., 2008)**	Pre/post test (quasi-experimental) study	116. Phase1: age ≥65, 2 or more chronic conditions and hospitalisation risk factors. Phase 2: age ≥50 ≥1 chronic condition.	67%	Flintshire case management intervention. Community based case management intervention.	**Healthcare use - mixed** 12-month post-intervention ED admissions were significantly lower, but differences in length of inpatient stay were not significant.

Moreno-Chico et al, 2021 **Spain** **(Moreno-Chico et al., 2021)**	Controlled quasi-experimental study	104 (1:1 intervention/ control) people with chronic conditions (high prevalence multimorbidity and intervention explicitly designed for multimorbidity)	56%	Health-coaching intervention designed to support self-management.	**Self-management behaviour - mixed** Immediate improvement in patient activation [Patient Activation Measure (PAM-13)] at 6-weeks, not sustained at 6 or 12 months. **Health related quality of life - mostly unaffected** No significant difference between groups at any timepoint [SF-12] **Mental health - mostly unaffected** No significant difference between groups at any timepoint [Goldberg Anxiety and Depression Scale (GADS)] **Self-efficacy - mostly unaffected** No significant difference between groups at any timepoint [General Self-Efficacy scale (GSE)] **Adherence - mostly unaffected** No significant difference between groups in relation to medication adherence at any timepoint [Morisky Medication Adherence scale] **Quality of health care - mostly unaffected**

Study, location and report(s) cited†	Design	Participants	Summary quality score‡	Intervention	Summary of key findings [outcome measure] §
					No significant difference between groups at any timepoint [4-point Likert-type scale]
Piñeiro-Fernández et al, 2022 **Spain** **(Piñeiro-Fernández et al., 2022)**	Pre/post test (quasi-experimental) study	161 people with polypathology or complex chronic disease (one condition plus organ failure, polypharmacy or significant health service use).	89%	Nurse case management with proactive telephone contact, care coordination and potential for telemedicine.	**Health care use – mostly improved** Emergency department use and admission were lower at 6 months post-intervention compared with 6 months pre-intervention. Emergency department use and admission were lower at 12 months post-intervention compared with 12 months pre-intervention.

Study, location and report(s) cited†	Design	Participants	Summary quality score‡	Intervention	Summary of key findings [outcome measure] §
Randall et al, 2015 **UK, England** **(Randall et al., 2014)** **(Randall et al., 2015)**	Qualitative (descriptive/ exploratory)	2 phases: Phase 1: 43 Phase 2: 45 Community matrons, patients, carers, managers, former commissioners, GPs, secondary care staff	80%	Community Matrons Community-based advanced nurse case management intervention	**Quality of healthcare - mixed** There were many illustrations where patients and staff felt patient care had been improved by the intervention, but also gaps identified particularly in communicating with secondary care. **Communication - mostly improved** Communicating with the community matrons was seen as easy and preferable to going through GP surgery **Self-management behaviour - mostly improved** There were illustrations of participants engaged in good self-management behaviours, which were credited to the community matrons' intervention
Sadarangani et al, 2019 USA **(Sadarangani et al., 2019)**	Mixed methods: pre/post test (quasi-experimental) study, with qualitative descriptive/ exploratory interviews	Quantitative phase: 126. Age ≥18, combination of >1 chronic conditions, psychosocial conditions and hospitalisation risk.	Quant: 67% Qual: 80%	Community-based health home. Case management intervention delivered by a registered nurse	**Mental health - mostly improved** Severe depression was reduced at 12 months [Geriatric Depression Scale]. There was also a reduction in loneliness

Study, location and report(s) cited†	Design	Participants	Summary quality score‡	Intervention	Summary of key findings [outcome measure] §
		Qualitative phase: 40 stakeholders (patients, carers, administrators, nurses, social workers)		navigator with interdisciplinary team	[UCLA Loneliness Scale], and a borderline significant improvement in cognitive impairment [Orientation Memory Cognition Tool] **Health related quality of life - mostly improved** There was a significant increase in the number of people reporting good quality of life at 12 months [Revised Dementia Quality of Life Self-Esteem subscale] **Healthcare use - mixed** There was a significant reduction in ED use over the preceding 12 months but no difference in hospitalisation. **Prioritisation - mostly improved** There was qualitative evidence of nurses engaging in patient-centred goal setting, and that patients appreciated this approach **Self-management behaviour - mostly improved** There was qualitative evidence of patients adopting positive health

Study, location and report(s) cited†	Design	Participants	Summary quality score‡	Intervention	Summary of key findings [outcome measure] §
					behaviours as a result of intervention **Nutrition - mostly improved** There was a significant reduction in proportion of those at 'high nutritional risk' at 12 months [DETERMINE checklist] **Falls risk - mostly unaffected** The proportion of those at 'high-risk' of falls was marginally higher post-intervention [STEADI assessment]. Authors attribute this to likely disease progression or improved detection of high-risk individuals. **Pain - mostly improved** There was a significant reduction in the number of people reporting poorly controlled pain at 12 months [Modified Universal Pain Assessment Tool] **Proactive case-finding - mostly improved** There was qualitative evidence to indicate the intervention improved early detection of high-

Study, location and report(s) cited†	Design	Participants	Summary quality score‡	Intervention	Summary of key findings [outcome measure] §
					risk patients and appropriate referral **Disease management - mostly improved** There was qualitative evidence to indicate nurses provided effective disease management and early detection of deterioration in health status **Trust and advocacy - mostly improved** There was qualitative evidence to indicate nurses provided an advocacy role for the patients with other health and social care providers **Caregiver support - mostly improved** There was qualitative evidence to suggest nurses were involved in proactively identifying and supporting caregivers

Study, location and report(s) cited†	Design	Participants	Summary quality score‡	Intervention	Summary of key findings [outcome measure] §
Steinman et al, 2018 **Israel** **(Steinman et al., 2018)**	Cluster-controlled (quasi-experimental) clinical trial	1,218 (622 intervention, 596 control). Age 45-94, 3 or more chronic conditions, high hospitalisation risk determined by predictive modelling	89%	Comprehensive Care of Multimorbid Adults Project (CC-MAP) Primary care case management intervention, based on Guided Care model.	**Prioritisation - mostly improved** There was a significant increase in the number of medication changes and symptom-focussed medication changes (yet no increase in number of medication) in the intervention group, interpreted as a 'fine-tuning' of medications in a patient-centred manner
Taveira et al, 2019 **Portugal** **(Taveira et al., 2019)**	Pre/post test (quasi-experimental) study	50. Adults (no age restriction) ≥2 chronic illnesses	33%	Primary care nurse case manager within an integrative care team	**Healthcare use - mostly improved** Reductions in ED admission, basic ED usage, family doctor and specialist consultations, and inpatient admissions were all reduced.

Study, location and report(s) cited†	Design	Participants	Summary quality score‡	Intervention	Summary of key findings [outcome measure] §
Valdivieso et al, 2018 Spain **(Valdivieso et al., 2018)**	Controlled (quasi-experimental) clinical trial (3 arms)	472 (78 telehealth arm, 168 phone arm, 170 control) Age ≥18, multimorbid population identified using predictive modelling	56%	Hospital case management nurse intervention. Phone arm made contact by telephone only, telehealth arm also used Bluetooth enabled devices for physiological monitoring.	**Mortality - mostly unaffected** No differences detected in mortality between groups at 12 months **Mental health - mostly improved** The telephone group saw a reduction in cognitive impairment [Pfeiffer Score] over 12 months, but not the telehealth group **Health related quality of life - mostly improved** Both intervention arms were associated with improved [EQ-5D] scores, and the telehealth group also had improved [EQ-5D VAS] at 12 months **Activities of daily living - mostly improved** The telephone group had improved functional ability/ADLs at 12 months compared to control [Barthel Index] **Healthcare use - mostly unaffected** There was no reduction between groups for any aspect of healthcare utilisation.

Study, location and report(s) cited†	Design	Participants	Summary quality score‡	Intervention	Summary of key findings [outcome measure] §
Yang et al, 2022 China (Yang et al., 2022)	Randomised controlled trial	136(67 intervention, 69 control) people aged ≥60 with ≥2 or more conditions, prescribed medications and evidence of non-adherence to medications.	77%	Nurse-led intervention to improve self-management in relation to medications. 6-week intervention with 3 face-to-face education sessions and telephone follow-up.	**Adherence - mixed** Short term improvement in medication adherence, no difference in groups noted at 3 months post-intervention [5-item Medication Adherence Report Scale (MARS-5)]. **Self-management behaviour - mixed** Short term improvement in ability to self-manage medications, no difference in groups noted at 3 months post-intervention [multiple instruments]. **Health-related quality of life - mostly unaffected** No significant differences in health-related quality of life noted [EQ-5D-5L]. **Treatment burden - mostly unaffected** No significant differences noted in relation to overall treatment burden [Treatment Burden Questionnaire] **Healthcare use – mostly unaffected** No difference between groups in relation to healthcare use at any timepoints.

Study, location and report(s) cited†	Design	Participants	Summary quality score‡	Intervention	Summary of key findings [outcome measure] §

† Study title decided based on either the principal investigator (if known), or the first author of the most recent or significant publication. This does not signify authorship as determined by the publication authors.

‡ Summary quality scores calculated as a percentage of the domains in the scoring tool which were scored ‘yes’

§ Outcome measures in parentheses where identified by study authors

T2DM = type 2 diabetes mellitus, ED = emergency department, ICU = intensive care unit, CM = case manager, QALY = quality-adjusted life years, ADL = activities of daily living, GC = Guided Care

Appendix 12

Quality of studies included in the systematic review

All summary scores were calculated as the percentage of questions which were marked ‘Yes’. Any rows marked ‘No’, ‘NA’ or ‘Unclear’ did not count towards the score. Summary scores do not represent any generalisable level of quality and are only intended for comparisons between studies.

Randomised controlled trials

	Boult et al 2011	Chow & Wong 2014	Gabbard et al 2021	Markle-Reid et al 2020	Markle-Reid et al 2021	Yang et al 2022
True randomisation?	Yes	Yes	Yes	Yes	Yes	Yes
Allocation concealment?	Yes	Yes	Yes	Yes	Yes	Yes
Groups similar at baseline?	No	Unclear	Yes	Yes	No	Yes
Participants blinded?	NA	Yes	NA	NA	Yes	NA
Treating clinician blinded?	NA	NA	NA	NA	NA	NA
Outcome assessors blinded?	Yes	Yes	Unclear	Yes	Yes	Yes
Treatment identical apart from intervention?	Yes	Yes	Yes	No	Yes	Yes
Follow-up complete?	Yes	Yes	Yes	Yes	Yes	Yes
Analysed in randomly allocated groups?	Yes	Yes	Yes	Yes	Yes	Yes
Outcomes measured the same between groups?	Yes	Yes	Yes	Yes	Yes	Yes
Outcomes measured reliably?	Yes	Yes	Yes	Yes	Yes	Yes
Appropriate statistical analysis?	Yes	Yes	Yes	Yes	No	Yes
Appropriate design or deviations (e.g. cluster-RCTs)?	Yes	Yes	Yes	Yes	Yes	Yes
Summary score	77%	85%	77%	77%	77%	77%

Quasi-experimental studies

	Boult et al 2008	Dorr et al 2008	Lowe et al 2022	Lupari 2011	Mallow et al 2018	Markle-Reid et al 2016	Mesa-Melgarejo et al 2022	Moran et al 2008	Moreno-Chico et al 2021	Piñeiro-Fernández et al 2022	Sadarangani et al 2019	Steinman et al 2018	Taveira et al 2019	Valdivieso et al 2018
‘Cause’ and ‘effect’ clearly differentiated?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Groups similar at baseline?	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No
Treatment similar apart from intervention?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	Yes
Was there a control group?	Yes	Yes	No	Yes	No	No	No	No	No	No	No	Yes	No	Yes
Multiple measures of outcome pre/post?	No	Yes	No	Yes	Yes	No	No	No	No	Yes	No	Yes	Unclear	Unclear
Follow-up complete?	No	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	No	No
Outcomes measured same way?	Yes	Unclear	NA	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Outcomes measured reliably?	Yes	Yes	Unclear	Yes	No	Yes	Yes	Yes	No	Yes	No	Yes	Unclear	Yes
Appropriate statistical analysis?	Yes	Yes	Unclear	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
Summary score	67%	89%	44%	89%	44%	78%	67%	67%	56%	89%	67%	89%	33%	56%

Cohort studies

	Garcia-Fernandez et al 2014	Hanson et al 2018	Hummel et al 2017	Jackson et al 2017
Groups similar and from same population?	Yes	Yes	No	No
Exposures measured similarly to assign to groups?	Yes	Yes	Yes	Yes
Exposure measurement valid and reliable?	Yes	Yes	Yes	Yes
Confounding factors identified?	No	Yes	Yes	Yes
Strategies for confounders stated?	No	Yes	Yes	Yes
Free of outcome at start of study?	Yes	Yes	Yes	Yes
Outcome measurement valid and reliable?	Unclear	Yes	No	Yes
Long enough follow-up time?	Yes	Yes	Yes	Yes
Follow-up complete?	Unclear	Yes	No	Yes
Strategies to address incomplete follow-up?	Unclear	Yes	No	Yes
Appropriate statistical analysis?	Yes	Yes	No	Yes
Summary score	55%	100%	55%	91%

Qualitative studies

	Doyle et al 2022	Hjelm et al 2015	Karlsson & Karlsson 2019	Lupari 2011	Mesa-Melgarejo et al 2022	Randall et al 2015	Sadarangani et al 2019
Congruity between philosophical perspective and methodology?	Unclear	Yes	No	Yes	No	Yes	Yes
Congruity between methodology and research question/objectives?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Congruity between methodology and data collection?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Congruity between methodology and data representation/analysis?	Yes	Yes	Yes	Yes	No	Yes	Yes
Congruity between methodology and interpretation of results?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Statement to locate researcher culturally or theoretically?	No	No	No	No	No	No	No
Influence between researcher and research addressed?	No	Yes	No	Yes	No	No	No
Are participants and their voices adequately represented?	Yes	Yes	No	Yes	No	Yes	Yes
Is research ethical or is there evidence of ethical approval?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Do the conclusions flow from the analysis/interpretation of data?	Yes	Yes	No	Yes	Yes	Yes	Yes
Summary score	70%	90%	50%	90%	50%	80%	80%

For further information on the JBI tools, these are discussed in the JBI manual for evidence synthesis and in published papers:

Randomised controlled trials/quasi-experimental studies (Tufanaru et al., 2020): https://doi.org/https://doi.org/10.46658/JBIMES-20-01

Cohort studies (Moola et al., 2020): https://doi.org/https://doi.org/10.46658/JBIMES-20-01

Qualitative studies (Lockwood et al., 2015): https://doi.org/10.1097/xeb.0000000000000062

Appendix 13

Model summaries for complete case analysis

Multimorbidity models

Model 1: Multimorbidity and admission (unadjusted)

	ADMITTED		
Exposures	*Odds Ratios*	*95% CI*	*p*
MULTIMORBIDITY	6.24	5.97 – 6.53	**<0.001**
Observations	63328		
R^2 Tjur	0.119		

Model 2: Multimorbidity and admission (adjusted)

	ADMITTED		
Exposures	*Odds Ratios*	*95% CI*	*p*
MULTIMORBIDITY	4.15	3.96 – 4.35	**<0.001**
AGE	1.03	1.03 – 1.03	**<0.001**
SEX [M]	1.03	1.00 – 1.07	0.068
ETHNICITY [Asian]	0.85	0.77 – 0.93	**<0.001**
ETHNICITY [African]	0.89	0.74 – 1.07	0.237
ETHNICITY [Mixed or multiple ethnic groups]	1.20	1.01 – 1.43	**0.034**
ETHNICITY [Other ethnic groups]	0.68	0.51 – 0.89	**0.007**
ETHNICITY [Arabic]	1.14	0.71 – 1.80	0.566
ETHNICITY [Caribbean]	0.86	0.37 – 1.80	0.694
SIMD DECILE [2]	0.94	0.90 – 0.99	**0.014**
SIMD DECILE [3]	0.96	0.90 – 1.03	0.232
SIMD DECILE [4]	0.96	0.89 – 1.03	0.245
SIMD DECILE [5]	0.96	0.89 – 1.03	0.285
SIMD DECILE [6]	0.93	0.85 – 1.01	0.086
SIMD DECILE [7]	0.93	0.85 – 1.03	0.149
SIMD DECILE [8]	0.99	0.90 – 1.08	0.772
SIMD DECILE [9]	0.96	0.87 – 1.05	0.367
SIMD DECILE [10]	0.77	0.68 – 0.86	**<0.001**
Observations	63328		
R^2 Tjur	0.165		

Model 3: Multimorbidity and 30-day reattendance (unadjusted)

	30 DAY REATTENDANCE		
Exposures	*Odds Ratios*	*95% CI*	*p*
MULTIMORBIDITY	2.10	1.99 – 2.21	**<0.001**
Observations	61775		
R^2 Tjur	0.014		

Model 4: Multimorbidity and 30-day reattendance (adjusted)

	30 DAY REATTENDANCE		
Exposures	*Odds Ratios*	*95% CI*	*p*
MULTIMORBIDITY	2.21	2.09 – 2.34	**<0.001**
AGE	1.00	1.00 – 1.00	**<0.001**
SEX [M]	1.11	1.06 – 1.16	**<0.001**
ETHNICITY [Asian]	0.99	0.87 – 1.11	0.831
ETHNICITY [African]	0.93	0.72 – 1.19	0.573
ETHNICITY [Mixed or multiple ethnic groups]	1.42	1.14 – 1.74	**0.001**
ETHNICITY [Other ethnic groups]	1.02	0.71 – 1.42	0.901
ETHNICITY [Arabic]	1.07	0.55 – 1.90	0.829
ETHNICITY [Caribbean]	1.57	0.59 – 3.57	0.317
SIMD DECILE [2]	0.98	0.92 – 1.05	0.632
SIMD DECILE [3]	0.81	0.74 – 0.89	**<0.001**
SIMD DECILE [4]	0.92	0.83 – 1.01	0.079
SIMD DECILE [5]	0.85	0.77 – 0.94	**0.002**
SIMD DECILE [6]	0.95	0.85 – 1.06	0.401
SIMD DECILE [7]	0.81	0.71 – 0.93	**0.002**
SIMD DECILE [8]	0.79	0.69 – 0.90	**<0.001**
SIMD DECILE [9]	0.72	0.62 – 0.83	**<0.001**
SIMD DECILE [10]	0.70	0.58 – 0.83	**<0.001**
Observations	61775		
R^2 Tjur	0.016		

Model 5: Multimorbidity and 90-day reattendance (unadjusted)

	90 DAY REATTENDANCE		
Exposures	*Odds Ratios*	*95% CI*	*p*
MULTIMORBIDITY	3.13	3.00 – 3.26	**<0.001**
Observations	61241		
R^2 Tjur	0.048		

Model 6: Multimorbidity and 90-day reattendance (adjusted)

	90 DAY REATTENDANCE		
Exposures	*Odds Ratios*	*95% CI*	*p*
MULTIMORBIDITY	3.11	2.96 – 3.26	**<0.001**
AGE	1.00	1.00 – 1.00	0.976
SEX [M]	1.09	1.05 – 1.13	**<0.001**
ETHNICITY [Asian]	0.95	0.86 – 1.05	0.319
ETHNICITY [African]	1.00	0.81 – 1.22	0.998
ETHNICITY [Mixed or multiple ethnic groups]	1.27	1.06 – 1.53	**0.010**
ETHNICITY [Other ethnic groups]	0.83	0.60 – 1.11	0.224
ETHNICITY [Arabic]	1.00	0.57 – 1.64	0.987
ETHNICITY [Caribbean]	1.26	0.53 – 2.69	0.568
SIMD DECILE [2]	0.96	0.91 – 1.01	0.119
SIMD DECILE [3]	0.88	0.82 – 0.95	**0.001**
SIMD DECILE [4]	0.91	0.85 – 0.99	**0.027**
SIMD DECILE [5]	0.81	0.75 – 0.88	**<0.001**
SIMD DECILE [6]	0.88	0.80 – 0.96	**0.006**
SIMD DECILE [7]	0.79	0.70 – 0.87	**<0.001**
SIMD DECILE [8]	0.70	0.63 – 0.78	**<0.001**
SIMD DECILE [9]	0.72	0.64 – 0.81	**<0.001**
SIMD DECILE [10]	0.62	0.53 – 0.72	**<0.001**
Observations	61241		
R^2 Tjur	0.051		

Model 7: Multimorbidity and inpatient mortality (unadjusted)

	INPATIENT MORTALITY		
Exposures	*Odds Ratios*	*95% CI*	*p*
MULTIMORBIDITY	1.86	1.64 – 2.11	**<0.001**
Observations	27362		
R^2 Tjur	0.004		

Model 8: Multimorbidity and inpatient mortality (adjusted)

	INPATIENT MORTALITY		
Exposures	*Odds Ratios*	*95% CI*	*p*
MULTIMORBIDITY	1.13	1.00 – 1.29	0.057
AGE	1.06	1.06 – 1.07	**<0.001**
SEX [M]	1.38	1.21 – 1.57	**<0.001**
ETHNICITY [Asian]	0.61	0.32 – 1.05	0.097
ETHNICITY [Other]	0.87	0.27 – 2.07	0.782
SIMD DECILE [2]	0.77	0.64 – 0.92	**0.005**
SIMD DECILE [3]	1.02	0.81 – 1.26	0.889
SIMD DECILE [4]	0.81	0.61 – 1.05	0.116
SIMD DECILE [5]	0.69	0.51 – 0.91	**0.011**
SIMD DECILE [6]	0.77	0.56 – 1.04	0.097
SIMD DECILE [7]	0.67	0.48 – 0.93	**0.020**
SIMD DECILE [8]	0.68	0.47 – 0.96	**0.035**
SIMD DECILE [9]	0.95	0.67 – 1.30	0.745
SIMD DECILE [10]	0.83	0.52 – 1.26	0.415
Observations	27362		
R^2 Tjur	0.033		

Complex multimorbidity models

Model 1: Complex multimorbidity and admission (unadjusted)

	ADMITTED		
Exposures	*Odds Ratios*	*95% CI*	*p*
COMPLEX MULTIMORBIDITY	6.51	6.09 – 6.97	**<0.001**
Observations	75723		
R^2 Tjur	0.050		

Model 2: Complex multimorbidity and admission (adjusted)

	ADMITTED		
Exposures	*Odds Ratios*	*95% CI*	*p*
COMPLEX MULTIMORBIDITY	3.45	3.22 – 3.70	**<0.001**
AGE	1.03	1.03 – 1.03	**<0.001**
SEX [M]	1.05	1.01 – 1.08	**0.007**
ETHNICITY [Asian]	0.42	0.40 – 0.46	**<0.001**
ETHNICITY [African]	0.70	0.61 – 0.79	**<0.001**
ETHNICITY [Mixed or multiple ethnic groups]	2.00	1.77 – 2.25	**<0.001**
ETHNICITY [Other ethnic groups]	0.09	0.07 – 0.11	**<0.001**
ETHNICITY [Arabic]	1.26	1.10 – 1.44	**0.001**
ETHNICITY [Caribbean]	0.08	0.06 – 0.11	**<0.001**
SIMD DECILE [2]	0.94	0.90 – 0.98	**0.006**
SIMD DECILE [3]	0.98	0.92 – 1.04	0.485
SIMD DECILE [4]	0.93	0.87 – 0.99	**0.034**
SIMD DECILE [5]	0.94	0.88 – 1.01	0.101
SIMD DECILE [6]	0.92	0.85 – 0.99	**0.036**
SIMD DECILE [7]	0.92	0.84 – 1.00	0.051
SIMD DECILE [8]	0.95	0.88 – 1.03	0.255
SIMD DECILE [9]	0.87	0.80 – 0.96	**0.003**
SIMD DECILE [10]	0.71	0.64 – 0.80	**<0.001**
Observations	75723		
R^2 Tjur	0.161		

Model 3: Complex multimorbidity and 30-day reattendance (unadjusted)

	30 DAY REATTENDANCE		
Exposures	*Odds Ratios*	*95% CI*	*p*
COMPLEX MULTIMORBIDITY	2.41	2.25 – 2.58	**<0.001**
Observations	74383		
R^2 Tjur	0.009		

Model 4: Complex multimorbidity and 30-day reattendance (adjusted)

	30 DAY REATTENDANCE		
Exposures	*Odds Ratios*	*95% CI*	*p*
COMPLEX MULTIMORBIDITY	2.22	2.07 – 2.39	**<0.001**
AGE	1.00	1.00 – 1.00	0.246
SEX [M]	1.12	1.07 – 1.17	**<0.001**
ETHNICITY [Asian]	0.56	0.51 – 0.62	**<0.001**
ETHNICITY [African]	0.47	0.38 – 0.58	**<0.001**
ETHNICITY [Mixed or multiple ethnic groups]	1.65	1.42 – 1.92	**<0.001**
ETHNICITY [Other ethnic groups]	0.31	0.25 – 0.38	**<0.001**
ETHNICITY [Arabic]	0.65	0.52 – 0.80	**<0.001**
ETHNICITY [Caribbean]	1.25	1.07 – 1.45	**0.005**
SIMD DECILE [2]	0.95	0.90 – 1.01	0.093
SIMD DECILE [3]	0.76	0.69 – 0.82	**<0.001**
SIMD DECILE [4]	0.85	0.77 – 0.93	**<0.001**
SIMD DECILE [5]	0.82	0.75 – 0.90	**<0.001**
SIMD DECILE [6]	0.90	0.81 – 1.00	0.060
SIMD DECILE [7]	0.80	0.70 – 0.90	**<0.001**
SIMD DECILE [8]	0.79	0.70 – 0.89	**<0.001**
SIMD DECILE [9]	0.71	0.62 – 0.81	**<0.001**
SIMD DECILE [10]	0.69	0.59 – 0.81	**<0.001**
Observations	74383		
R^2 Tjur	0.016		

Model 5: Complex multimorbidity and 90-day reattendance (unadjusted)

	90 DAY REATTENDANCE		
Exposures	*Odds Ratios*	*95% CI*	*p*
COMPLEX MULTIMORBIDITY	3.92	3.70 – 4.16	**<0.001**
Observations	73812		
R^2 Tjur	0.032		

Model 6: Complex multimorbidity and 90-day reattendance (adjusted)

	90 DAY REATTENDANCE		
Exposures	*Odds Ratios*	*95% CI*	*p*
COMPLEX MULTIMORBIDITY	3.27	3.08 – 3.48	**<0.001**
AGE	1.00	1.00 – 1.01	**<0.001**
SEX [M]	1.10	1.06 – 1.14	**<0.001**
ETHNICITY [Asian]	0.54	0.50 – 0.58	**<0.001**
ETHNICITY [African]	0.46	0.38 – 0.54	**<0.001**
ETHNICITY [Mixed or multiple ethnic groups]	1.40	1.22 – 1.60	**<0.001**
ETHNICITY [Other ethnic groups]	0.21	0.17 – 0.25	**<0.001**
ETHNICITY [Arabic]	0.63	0.53 – 0.75	**<0.001**
ETHNICITY [Caribbean]	0.92	0.80 – 1.06	0.277
SIMD DECILE [2]	0.92	0.87 – 0.96	**0.001**
SIMD DECILE [3]	0.82	0.77 – 0.88	**<0.001**
SIMD DECILE [4]	0.85	0.79 – 0.91	**<0.001**
SIMD DECILE [5]	0.78	0.72 – 0.84	**<0.001**
SIMD DECILE [6]	0.82	0.75 – 0.89	**<0.001**
SIMD DECILE [7]	0.76	0.69 – 0.84	**<0.001**
SIMD DECILE [8]	0.71	0.65 – 0.78	**<0.001**
SIMD DECILE [9]	0.67	0.60 – 0.75	**<0.001**
SIMD DECILE [10]	0.61	0.54 – 0.70	**<0.001**
Observations	73812		
R^2 Tjur	0.046		

Model 7: Complex multimorbidity and inpatient mortality (unadjusted)

	INPATIENT MORTALITY		
Exposures	*Odds Ratios*	*95% CI*	*p*
COMPLEX MULTIMORBDITY	1.56	1.34 – 1.81	**<0.001**
Observations	29966		
R^2 Tjur	0.001		

Model 8: Complex multimorbidity and inpatient mortality (adjusted)

	INPATIENT MORTALITY		
Exposures	*Odds Ratios*	*95% CI*	*p*
COMPLEX MULTIMORBIDITY	0.97	0.83 – 1.13	0.743
AGE	1.06	1.05 – 1.06	**<0.001**
SEX [M]	1.35	1.20 – 1.53	**<0.001**
ETHNICITY [Asian]	0.55	0.30 – 0.92	**0.037**
ETHNICITY [Other]	0.43	0.13 – 1.01	0.094
SIMD DECILE [2]	0.79	0.66 – 0.94	**0.008**
SIMD DECILE [3]	1.04	0.84 – 1.28	0.703
SIMD DECILE [4]	0.78	0.60 – 1.01	0.068
SIMD DECILE [5]	0.71	0.53 – 0.92	**0.013**
SIMD DECILE [6]	0.83	0.61 – 1.09	0.195
SIMD DECILE [7]	0.65	0.46 – 0.89	**0.010**
SIMD DECILE [8]	0.66	0.46 – 0.92	**0.019**
SIMD DECILE [9]	0.92	0.65 – 1.25	0.597
SIMD DECILE [10]	0.83	0.54 – 1.23	0.374
Observations	29966		
R^2 Tjur	0.033		

Disease-count models

Model 1: Disease-count and admission (unadjusted)

	ADMITTED		
Exposures	*Odds Ratios*	*95% CI*	*p*
DISEASE COUNT [1]	5.99	5.73 – 6.26	**<0.001**
DISEASE COUNT [2]	8.94	8.43 – 9.49	**<0.001**
DISEASE COUNT [3]	10.54	9.74 – 11.43	**<0.001**
DISEASE COUNT [4]	11.53	10.23 – 13.03	**<0.001**
DISEASE COUNT [5]	15.58	12.61 – 19.46	**<0.001**
DISEASE COUNT [6+]	21.99	15.07 – 33.38	**<0.001**
Observations	63328		
R^2 Tjur	0.220		

Model 2: Disease-count and admission (adjusted)

	ADMITTED		
Exposures	*Odds Ratios*	*95% CI*	*p*
DISEASE COUNT [1]	5.04	4.81 – 5.27	**<0.001**
DISEASE COUNT [2]	6.58	6.19 – 7.00	**<0.001**
DISEASE COUNT [3]	7.15	6.59 – 7.77	**<0.001**
DISEASE COUNT [4]	7.52	6.65 – 8.52	**<0.001**
DISEASE COUNT [5]	10.03	8.10 – 12.54	**<0.001**
DISEASE COUNT [6+]	14.31	9.79 – 21.76	**<0.001**
AGE	1.02	1.02 – 1.02	**<0.001**
SEX [M]	0.97	0.94 – 1.01	0.148
ETHNICITY [Asian]	0.92	0.83 – 1.01	0.073
ETHNICITY [African]	0.96	0.79 – 1.16	0.683
ETHNICITY [Mixed or multiple ethnic groups]	1.31	1.09 – 1.56	**0.003**
ETHNICITY [Other ethnic groups]	0.77	0.57 – 1.02	0.073
ETHNICITY [Arabic]	1.35	0.83 – 2.15	0.217
ETHNICITY [Caribbean]	0.89	0.37 – 1.94	0.773
SIMD DECILE [2]	0.96	0.92 – 1.01	0.149
SIMD DECILE [3]	1.01	0.94 – 1.08	0.835
SIMD DECILE [4]	1.00	0.93 – 1.08	0.973
SIMD DECILE [5]	1.03	0.95 – 1.11	0.470
SIMD DECILE [6]	0.98	0.90 – 1.07	0.692
SIMD DECILE [7]	1.00	0.90 – 1.10	0.973
SIMD DECILE [8]	1.11	1.01 – 1.22	**0.035**
SIMD DECILE [9]	1.07	0.97 – 1.19	0.183
SIMD DECILE [10]	0.84	0.74 – 0.95	**0.007**
Observations	63328		
R^2 Tjur	0.240		

Model 3: Disease-count and 30-day reattendance (unadjusted)

	30 DAY REATTENDANCE		
Exposures	*Odds Ratios*	*95% CI*	*p*
DISEASE COUNT [1]	1.85	1.74 – 1.96	**<0.001**
DISEASE COUNT [2]	2.25	2.10 – 2.41	**<0.001**
DISEASE COUNT [3]	2.47	2.26 – 2.69	**<0.001**
DISEASE COUNT [4]	2.89	2.56 – 3.26	**<0.001**
DISEASE COUNT [5]	3.82	3.19 – 4.56	**<0.001**
DISEASE COUNT [6+]	4.01	2.99 – 5.33	**<0.001**
Observations	61775		
R^2 Tjur	0.021		

Model 4: Disease-count and 30-day reattendance (adjusted)

	30 DAY REATTENDANCE		
Exposures	*Odds Ratios*	*95% CI*	*p*
DISEASE COUNT [1]	1.99	1.87 – 2.11	**<0.001**
DISEASE COUNT [2]	2.55	2.37 – 2.75	**<0.001**
DISEASE COUNT [3]	2.88	2.63 – 3.16	**<0.001**
DISEASE COUNT [4]	3.42	3.02 – 3.88	**<0.001**
DISEASE COUNT [5]	4.55	3.78 – 5.46	**<0.001**
DISEASE COUNT [6+]	4.76	3.54 – 6.34	**<0.001**
AGE	0.99	0.99 – 0.99	**<0.001**
SEX [M]	1.09	1.04 – 1.14	**<0.001**
ETHNICITY [Asian]	1.02	0.90 – 1.15	0.729
ETHNICITY [African]	0.96	0.74 – 1.23	0.774
ETHNICITY [Mixed or multiple ethnic groups]	1.47	1.18 – 1.80	**<0.001**
ETHNICITY [Other ethnic groups]	1.08	0.76 – 1.51	0.645
ETHNICITY [Arabic]	1.14	0.59 – 2.03	0.666
ETHNICITY [Caribbean]	1.63	0.61 – 3.72	0.280
SIMD DECILE [2]	1.00	0.93 – 1.06	0.896
SIMD DECILE [3]	0.83	0.76 – 0.91	**<0.001**
SIMD DECILE [4]	0.93	0.85 – 1.03	0.156
SIMD DECILE [5]	0.88	0.79 – 0.97	**0.013**
SIMD DECILE [6]	0.98	0.87 – 1.09	0.661
SIMD DECILE [7]	0.84	0.73 – 0.96	**0.009**
SIMD DECILE [8]	0.82	0.72 – 0.94	**0.004**
SIMD DECILE [9]	0.75	0.64 – 0.87	**<0.001**
SIMD DECILE [10]	0.73	0.61 – 0.87	**0.001**
Observations	61775		
R^2 Tjur	0.025		

Model 5: Disease-count and 90-day reattendance (unadjusted)

	90 DAY REATTENDANCE		
Exposures	*Odds Ratios*	*95% CI*	*p*
DISEASE COUNT [1]	2.32	2.21 – 2.43	**<0.001**
DISEASE COUNT [2]	3.25	3.07 – 3.44	**<0.001**
DISEASE COUNT [3]	3.96	3.69 – 4.26	**<0.001**
DISEASE COUNT [4]	5.82	5.24 – 6.45	**<0.001**
DISEASE COUNT [5]	7.82	6.62 – 9.25	**<0.001**
DISEASE COUNT [6+]	9.57	7.27 – 12.69	**<0.001**
Observations	61241		
R^2 Tjur	0.070		

Model 6: Disease-count and 90-day reattendance (adjusted)

	REATTEND_90		
Exposures	*Odds Ratios*	*95% CI*	*p*
DISEASE COUNT [1]	2.44	2.32 – 2.56	**<0.001**
DISEASE COUNT [2]	3.55	3.34 – 3.78	**<0.001**
DISEASE COUNT [3]	4.43	4.10 – 4.78	**<0.001**
DISEASE COUNT [4]	6.57	5.89 – 7.31	**<0.001**
DISEASE COUNT [5]	8.89	7.50 – 10.56	**<0.001**
DISEASE COUNT [6+]	10.79	8.18 – 14.34	**<0.001**
AGE	0.99	0.99 – 1.00	**<0.001**
SEX [M]	1.06	1.02 – 1.10	**0.002**
ETHNICITY [Asian]	0.99	0.89 – 1.10	0.850
ETHNICITY [African]	1.05	0.85 – 1.28	0.651
ETHNICITY [Mixed or multiple ethnic groups]	1.33	1.10 – 1.60	**0.003**
ETHNICITY [Other ethnic groups]	0.89	0.65 – 1.20	0.472
ETHNICITY [Arabic]	1.08	0.62 – 1.79	0.769
ETHNICITY [Caribbean]	1.32	0.55 – 2.84	0.499
SIMD DECILE [2]	0.97	0.92 – 1.03	0.308
SIMD DECILE [3]	0.90	0.84 – 0.97	**0.006**
SIMD DECILE [4]	0.93	0.86 – 1.01	0.085
SIMD DECILE [5]	0.84	0.77 – 0.92	**<0.001**
SIMD DECILE [6]	0.90	0.82 – 0.99	**0.031**
SIMD DECILE [7]	0.82	0.73 – 0.91	**<0.001**
SIMD DECILE [8]	0.74	0.66 – 0.83	**<0.001**
SIMD DECILE [9]	0.76	0.67 – 0.86	**<0.001**
SIMD DECILE [10]	0.66	0.56 – 0.76	**<0.001**
Observations	61241		
R^2 Tjur	0.073		

Model 7: Disease-count and inpatient mortality (unadjusted)

	INPATIENT MORTALITY		
Exposures	*Odds Ratios*	*95% CI*	*p*
DISEASE COUNT [1]	2.57	2.13 – 3.11	**<0.001**
DISEASE COUNT [2]	3.20	2.63 – 3.91	**<0.001**
DISEASE COUNT [3]	3.59	2.89 – 4.47	**<0.001**
DISEASE COUNT [4]	2.65	1.94 – 3.58	**<0.001**
DISEASE COUNT [5]	1.98	1.15 – 3.19	**0.009**
DISEASE COUNT [6+]	2.04	0.86 – 4.09	0.069
Observations	27362		
R^2 Tjur	0.007		

Model 8: Disease-count and inpatient mortality (adjusted)

	INPATIENT_DIED		
Exposures	*Odds Ratios*	*95% CI*	*p*
DISEASE COUNT [1]	1.81	1.49 – 2.20	**<0.001**
DISEASE COUNT [2]	1.78	1.46 – 2.18	**<0.001**
DISEASE COUNT [3]	1.76	1.41 – 2.21	**<0.001**
DISEASE COUNT [4]	1.24	0.90 – 1.68	0.180
DISEASE COUNT [5]	0.91	0.52 – 1.47	0.710
DISEASE COUNT [6+]	1.01	0.42 – 2.05	0.973
AGE	1.06	1.05 – 1.06	**<0.001**
SEX [M]	1.35	1.19 – 1.54	**<0.001**
ETHNICITY [Asian]	0.64	0.34 – 1.09	0.128
ETHNICITY [Other]	0.94	0.29 – 2.26	0.912
SIMD DECILE [2]	0.77	0.64 – 0.92	**0.005**
SIMD DECILE [3]	1.02	0.82 – 1.26	0.867
SIMD DECILE [4]	0.82	0.62 – 1.06	0.145
SIMD DECILE [5]	0.69	0.52 – 0.92	**0.013**
SIMD DECILE [6]	0.77	0.56 – 1.04	0.105
SIMD DECILE [7]	0.68	0.48 – 0.94	**0.024**
SIMD DECILE [8]	0.69	0.48 – 0.97	**0.040**
SIMD DECILE [9]	0.97	0.69 – 1.34	0.880
SIMD DECILE [10]	0.84	0.52 – 1.27	0.421
Observations	27362		
R^2 Tjur	0.035		

Appendix 14

Model summaries for post-imputation analysis

Multimorbidity models

Model 1: Multimorbidity and admission (unadjusted)

	ADMITTED		
Exposures	*Odds Ratios*	*95% CI*	*p*
MULTIMORBIDITY	7.15	6.85 – 7.47	**<0.001**
Observations	75723		
R^2 Tjur	0.127		

Model 2: Multimorbidity and admission (adjusted)

	ADMITTED		
Exposures	*Odds Ratios*	*95% CI*	*p*
MULTIMORBIDITY	4.22	4.03 – 4.42	**<0.001**
AGE	1.03	1.03 – 1.03	**<0.001**
SEX [M]	1.02	0.99 – 1.05	0.279
ETHNICITY [Asian]	0.45	0.42 – 0.48	**<0.001**
ETHNICITY [African]	0.77	0.68 – 0.88	**<0.001**
ETHNICITY [Mixed or multiple ethnic groups]	2.10	1.86 – 2.37	**<0.001**
ETHNICITY [Other ethnic groups]	0.10	0.08 – 0.13	**<0.001**
ETHNICITY [Arabic]	1.38	1.20 – 1.57	**<0.001**
ETHNICITY [Caribbean]	0.09	0.06 – 0.12	**<0.001**
SIMD DECILE [2]	0.95	0.91 – 0.99	**0.024**
SIMD DECILE [3]	1.01	0.95 – 1.07	0.826
SIMD DECILE [4]	0.97	0.90 – 1.03	0.321
SIMD DECILE [5]	0.97	0.91 – 1.04	0.433
SIMD DECILE [6]	0.96	0.89 – 1.04	0.303
SIMD DECILE [7]	0.95	0.87 - 1.04	0.234
SIMD DECILE [8]	1.00	0.92 – 1.09	0.907
SIMD DECILE [9]	0.95	0.87 – 1.04	0.276
SIMD DECILE [10]	0.78	0.70 – 0.87	**<0.001**
Observations	75723		
R^2 Tjur	0.197		

Model 3: Multimorbidity and 30-day reattendance (unadjusted)

	30 DAY REATTENDANCE		
Exposures	*Odds Ratios*	*95% CI*	*p*
MULTIMORBIDITY	2.23	2.13 – 2.35	**<0.001**
Observations	74383		
R^2 Tjur	0.015		

Model 4: Multimorbidity and 30-day reattendance (adjusted)

	30 DAY REATTENDANCE		
Exposures	*Odds Ratios*	*95% CI*	*p*
MULTIMORBIDITY	2.18	2.07 – 2.31	**<0.001**
AGE	1.00	1.00 – 1.00	**<0.001**
SEX [M]	1.11	1.06 – 1.16	**<0.001**
ETHNICITY [Asian]	0.58	0.53 – 0.65	**<0.001**
ETHNICITY [African]	0.50	0.40 – 0.61	**<0.001**
ETHNICITY [Mixed or multiple ethnic groups]	1.71	1.46 – 1.98	**<0.001**
ETHNICITY [Other ethnic groups]	0.33	0.27 – 0.40	**<0.001**
ETHNICITY [Arabic]	0.68	0.55 – 0.84	**0.001**
ETHNICITY [Caribbean]	1.30	1.11 – 1.52	**0.001**
SIMD DECILE [2]	0.95	0.90 – 1.01	0.124
SIMD DECILE [3]	0.77	0.70 – 0.83	**<0.001**
SIMD DECILE [4]	0.86	0.79 – 0.95	**0.002**
SIMD DECILE [5]	0.83	0.75 – 0.91	**<0.001**
SIMD DECILE [6]	0.92	0.83 – 1.02	0.118
SIMD DECILE [7]	0.81	0.71 – 0.91	**0.001**
SIMD DECILE [8]	0.81	0.72 – 0.91	**<0.001**
SIMD DECILE [9]	0.74	0.64 – 0.84	**<0.001**
SIMD DECILE [10]	0.72	0.61 – 0.84	**<0.001**
Observations	74383		
R^2 Tjur	0.021		

Model 5: Multimorbidity and 90-day reattendance (unadjusted)

	90 DAY REATTENDANCE		
Exposures	*Odds Ratios*	*95% CI*	*p*
MULTIMORBIDITY	3.42	3.28 – 3.56	**<0.001**
Observations	73812		
R^2 Tjur	0.051		

Model 6: Multimorbidity and 90-day reattendance (adjusted)

	90 DAY REATTENDANCE		
Exposures	*Odds Ratios*	*95% CI*	*p*
MULTIMORBIDITY	3.11	2.97 – 3.25	**<0.001**
AGE	1.00	1.00 – 1.00	0.755
SEX [M]	1.07	1.04 – 1.11	**<0.001**
ETHNICITY [Asian]	0.57	0.52 – 0.62	**<0.001**
ETHNICITY [African]	0.49	0.42 – 0.58	**<0.001**
ETHNICITY [Mixed or multiple ethnic groups]	1.47	1.28 – 1.68	**<0.001**
ETHNICITY [Other ethnic groups]	0.23	0.19 – 0.27	**<0.001**
ETHNICITY [Arabic]	0.68	0.57 – 0.80	**<0.001**
ETHNICITY [Caribbean]	0.98	0.85 – 1.13	0.822
SIMD DECILE [2]	0.92	0.88 – 0.97	**0.001**
SIMD DECILE [3]	0.84	0.78 – 0.90	**<0.001**
SIMD DECILE [4]	0.87	0.81 – 0.94	**<0.001**
SIMD DECILE [5]	0.79	0.73 – 0.85	**<0.001**
SIMD DECILE [6]	0.84	0.77 – 0.91	**<0.001**
SIMD DECILE [7]	0.77	0.70 – 0.86	**<0.001**
SIMD DECILE [8]	0.73	0.66 – 0.81	**<0.001**
SIMD DECILE [9]	0.71	0.63 – 0.79	**<0.001**
SIMD DECILE [10]	0.65	0.56 – 0.74	**<0.001**
Observations	73812		
R^2 Tjur	0.060		

Model 7: Multimorbidity and inpatient mortality (unadjusted)

	INPATIENT MORTALITY		
Exposures	*Odds Ratios*	*CI*	*p*
MULTIMORBIDITY	1.94	1.72 – 2.18	**<0.001**
Observations	29966		
R^2 Tjur	0.004		

Model 8: Multimorbidity and inpatient mortality (adjusted)

	INPATIENT MORTALITY		
Exposures	*Odds Ratios*	*95% CI*	*p*
MULTIMORBIDITY	1.14	1.00 – 1.29	**0.042**
AGE	1.06	1.05 – 1.06	**<0.001**
SEX [M]	1.35	1.19 – 1.53	**<0.001**
ETHNICITY [Asian]	0.55	0.30 – 0.93	**0.037**
ETHNICITY [Other]	0.44	0.14 – 1.04	0.106
SIMD DECILE [2]	0.79	0.66 – 0.94	**0.008**
SIMD DECILE [3]	1.05	0.85 – 1.29	0.652
SIMD DECILE [4]	0.79	0.60 – 1.02	0.076
SIMD DECILE [5]	0.71	0.54 – 0.93	**0.016**
SIMD DECILE [6]	0.83	0.62 – 1.10	0.214
SIMD DECILE [7]	0.65	0.46 – 0.90	**0.011**
SIMD DECILE [8]	0.67	0.47 – 0.93	**0.022**
SIMD DECILE [9]	0.94	0.67 – 1.28	0.690
SIMD DECILE [10]	0.85	0.55 – 1.25	0.432
Observations	29966		
R^2 Tjur	0.033		

Complex multimorbidity models

Model 1: Complex multimorbidity and admission (unadjusted)

	ADMITTED		
Exposures	*Odds Ratios*	*95% CI*	*p*
COMPLEX MULTIMORBIDITY	6.51	6.09 – 6.97	**<0.001**
Observations	75723		
R^2 Tjur	0.050		

Model 2: Complex multimorbidity and admission (adjusted)

	ADMITTED		
Exposures	*Odds Ratios*	*95% CI*	*p*
COMPLEX MULTIMORBIDITY	3.45	3.22 – 3.70	**<0.001**
AGE	1.03	1.03 – 1.03	**<0.001**
SEX [M]	1.05	1.01 – 1.08	**0.007**
ETHNICITY [Asian]	0.42	0.40 – 0.46	**<0.001**
ETHNICITY [African]	0.70	0.61 – 0.79	**<0.001**
ETHNICITY [Mixed or multiple ethnic groups]	2.00	1.77 – 2.25	**<0.001**
ETHNICITY [Other ethnic groups]	0.09	0.07 – 0.11	**<0.001**
ETHNICITY [Arabic]	1.26	1.10 – 1.44	**0.001**
ETHNICITY [Caribbean]	0.08	0.06 – 0.11	**<0.001**
SIMD DECILE [2]	0.94	0.90 – 0.98	**0.006**
SIMD DECILE [3]	0.98	0.92 – 1.04	0.485
SIMD DECILE [4]	0.93	0.87 – 0.99	**0.034**
SIMD DECILE [5]	0.94	0.88 – 1.01	0.101
SIMD DECILE [6]	0.92	0.85 – 0.99	**0.036**
SIMD DECILE [7]	0.92	0.84 – 1.00	0.051
SIMD DECILE [8]	0.95	0.88 – 1.03	0.255
SIMD DECILE [9]	0.87	0.80 – 0.96	**0.003**
SIMD DECILE [10]	0.71	0.64 – 0.80	**<0.001**
Observations	75723		
R^2 Tjur	0.161		

Model 3: Complex multimorbidity and 30-day reattendance (unadjusted)

	30 DAY REATTENDANCE		
Exposures	*Odds Ratios*	*95% CI*	*p*
COMPLEX MULTIMORBIDITY	2.41	2.25 – 2.58	**<0.001**
Observations	74383		
R² Tjur	0.009		

Model 4: Complex multimorbidity and 30-day reattendance (adjusted)

	30 DAY REATTENDANCE		
Exposures	*Odds Ratios*	*95% CI*	*p*
COMPLEX MULTIMORBIDITY	2.22	2.07 – 2.39	**<0.001**
AGE	1.00	1.00 – 1.00	0.246
SEX [M]	1.12	1.07 – 1.17	**<0.001**
ETHNICITY [Asian]	0.56	0.51 – 0.62	**<0.001**
ETHNICITY [African]	0.47	0.38 – 0.58	**<0.001**
ETHNICITY [Mixed or multiple ethnic groups]	1.65	1.42 – 1.92	**<0.001**
ETHNICITY [Other ethnic groups]	0.31	0.25 – 0.38	**<0.001**
ETHNICITY [Arabic]	0.65	0.52 – 0.80	**<0.001**
ETHNICITY [Caribbean]	1.25	1.07 – 1.45	**0.005**
SIMD DECILE [2]	0.95	0.90 – 1.01	0.093
SIMD DECILE [3]	0.76	0.69 – 0.82	**<0.001**
SIMD DECILE [4]	0.85	0.77 – 0.93	**<0.001**
SIMD DECILE [5]	0.82	0.75 – 0.90	**<0.001**
SIMD DECILE [6]	0.90	0.81 – 1.00	0.060
SIMD DECILE [7]	0.80	0.70 – 0.90	**<0.001**
SIMD DECILE [8]	0.79	0.70 – 0.89	**<0.001**
SIMD DECILE [9]	0.71	0.62 – 0.81	**<0.001**
SIMD DECILE [10]	0.69	0.59 – 0.81	**<0.001**
Observations	74383		
R² Tjur	0.016		

Model 5: Complex multimorbidity and 90-day reattendance (unadjusted)

	90 DAY REATTENDANCE		
Exposures	*Odds Ratios*	*95%*	*p*
COMPLEX MULTIMORBIDITY	3.92	3.70 – 4.16	**<0.001**
Observations	73812		
R^2 Tjur	0.032		

Model 6: Complex multimorbidity and 90-day reattendance (adjusted)

	90 DAY REATTENDANCE		
Exposures	*Odds Ratios*	*95% CI*	*p*
COMPLEX MULTIMORBIDITY	3.27	3.08 – 3.48	**<0.001**
AGE	1.00	1.00 – 1.01	**<0.001**
SEX [M]	1.10	1.06 – 1.14	**<0.001**
ETHNICITY [Asian]	0.54	0.50 – 0.58	**<0.001**
ETHNICITY [African]	0.46	0.38 – 0.54	**<0.001**
ETHNICITY [Mixed or multiple ethnic groups]	1.40	1.22 – 1.60	**<0.001**
ETHNICITY [Other ethnic groups]	0.21	0.17 – 0.25	**<0.001**
ETHNICITY [Arabic]	0.63	0.53 – 0.75	**<0.001**
ETHNICITY [Caribbean]	0.92	0.80 – 1.06	0.277
SIMD DECILE [2]	0.92	0.87 – 0.96	**0.001**
SIMD DECILE [3]	0.82	0.77 – 0.88	**<0.001**
SIMD DECILE [4]	0.85	0.79 – 0.91	**<0.001**
SIMD DECILE [5]	0.78	0.72 – 0.84	**<0.001**
SIMD DECILE [6]	0.82	0.75 – 0.89	**<0.001**
SIMD DECILE [7]	0.76	0.69 – 0.84	**<0.001**
SIMD DECILE [8]	0.71	0.65 – 0.78	**<0.001**
SIMD DECILE [9]	0.67	0.60 – 0.75	**<0.001**
SIMD DECILE [10]	0.61	0.54 – 0.70	**<0.001**
Observations	73812		
R^2 Tjur	0.046		

Model 7: Complex multimorbidity and inpatient mortality (unadjusted)

	INPATIENT MORTALITY		
Exposures	*Odds Ratios*	*95% CI*	*p*
COMPLEX MULTIMORBIDITY	1.56	1.34 – 1.81	**<0.001**
Observations	29966		
R^2 Tjur	0.001		

Model 8: Complex multimorbidity and inpatient mortality (adjusted)

	INPATIENT MORTALITY		
Exposures	*Odds Ratios*	*95% CI*	*p*
COMPLEX MULTIMORBIDITY	0.97	0.83 – 1.13	0.743
AGE	1.06	1.05 – 1.06	**<0.001**
SEX [M]	1.35	1.20 – 1.53	**<0.001**
ETHNICITY [Asian]	0.55	0.30 – 0.92	**0.037**
ETHNICITY [Other]	0.43	0.13 – 1.01	0.094
SIMD DECILE [2]	0.79	0.66 – 0.94	**0.008**
SIMD DECILE [3]	1.04	0.84 – 1.28	0.703
SIMD DECILE [4]	0.78	0.60 – 1.01	0.068
SIMD DECILE [5]	0.71	0.53 – 0.92	**0.013**
SIMD DECILE [6]	0.83	0.61 – 1.09	0.195
SIMD DECILE [7]	0.65	0.46 – 0.89	**0.010**
SIMD DECILE [8]	0.66	0.46 – 0.92	**0.019**
SIMD DECILE [9]	0.92	0.65 – 1.25	0.597
SIMD DECILE [10]	0.83	0.54 – 1.23	0.374
Observations	29966		
R^2 Tjur	0.033		

Disease-count models

Model 1: Disease-count and admission (unadjusted)

	ADMITTED		
Exposures	*Odds Ratios*	*95% CI*	*p*
DISEASE COUNT [1]	7.03	6.74 – 7.33	**<0.001**
DISEASE COUNT [2]	10.33	9.76 – 10.94	**<0.001**
DISEASE COUNT [3]	11.93	11.04 – 12.90	**<0.001**
DISEASE COUNT [4]	12.98	11.56 – 14.61	**<0.001**
DISEASE COUNT [5]	18.30	14.89 – 22.71	**<0.001**
DISEASE COUNT [6+]	23.90	16.65 – 35.53	**<0.001**
Observations	75723		
R^2 Tjur	0.239		

Model 2: Disease-count and admission (adjusted)

	ADMITTED		
Exposures	*Odds Ratios*	*95% CI*	*p*
DISEASE COUNT [1]	5.38	5.14 – 5.62	**<0.001**
DISEASE COUNT [2]	6.84	6.45 – 7.27	**<0.001**
DISEASE COUNT [3]	7.27	6.71 – 7.89	**<0.001**
DISEASE COUNT [4]	7.62	6.76 – 8.60	**<0.001**
DISEASE COUNT [5]	10.60	8.60 – 13.18	**<0.001**
DISEASE COUNT [6+]	14.04	9.76 – 20.91	**<0.001**
AGE	1.02	1.02 – 1.02	**<0.001**
SEX [M]	0.96	0.93 – 0.99	**0.017**
ETHNICITY [Asian]	0.54	0.50 – 0.58	**<0.001**
ETHNICITY [African]	0.96	0.84 – 1.09	0.495
ETHNICITY [Mixed or multiple ethnic groups]	2.46	2.17 – 2.79	**<0.001**
ETHNICITY [Other ethnic groups]	0.14	0.11 – 0.18	**<0.001**
ETHNICITY [Arabic]	1.92	1.67 – 2.19	**<0.001**
ETHNICITY [Caribbean]	0.12	0.08 – 0.16	**<0.001**
SIMD DECILE [2]	0.97	0.93 – 1.02	0.278
SIMD DECILE [3]	1.05	0.99 – 1.13	0.110
SIMD DECILE [4]	1.01	0.94 – 1.08	0.788
SIMD DECILE [5]	1.04	0.97 – 1.12	0.282
SIMD DECILE [6]	1.01	0.93 – 1.10	0.723
SIMD DECILE [7]	1.01	0.92 – 1.11	0.761
SIMD DECILE [8]	1.12	1.02 – 1.22	**0.013**
SIMD DECILE [9]	1.06	0.97 – 1.17	0.194
SIMD DECILE [10]	0.87	0.77 – 0.97	**0.013**
Observations	75723		
R^2 Tjur	0.270		

Model 3: Disease-count and 30-day reattendance (unadjusted)

	30 DAY REATTENDANCE		
Exposures	*Odds Ratios*	*95% CI*	*p*
DISEASE COUNT [1]	1.93	1.82 – 2.04	**<0.001**
DISEASE COUNT [2]	2.36	2.21 – 2.52	**<0.001**
DISEASE COUNT [3]	2.61	2.40 – 2.83	**<0.001**
DISEASE COUNT [4]	3.11	2.77 – 3.49	**<0.001**
DISEASE COUNT [5]	4.11	3.45 – 4.87	**<0.001**
DISEASE COUNT [6+]	4.20	3.15 – 5.54	**<0.001**
Observations	74383		
R^2 Tjur	0.022		

Model 4: Disease-count and 30-day reattendance (adjusted)

	30 DAY REATTENDANCE		
Exposures	*Odds Ratios*	*95% CI*	*p*
DISEASE COUNT [1]	1.94	1.83 – 2.06	**<0.001**
DISEASE COUNT [2]	2.48	2.31 – 2.66	**<0.001**
DISEASE COUNT [3]	2.81	2.57 – 3.07	**<0.001**
DISEASE COUNT [4]	3.39	3.00 – 3.83	**<0.001**
DISEASE COUNT [5]	4.51	3.77 – 5.37	**<0.001**
DISEASE COUNT [6+]	4.62	3.46 – 6.11	**<0.001**
AGE	0.99	0.99 – 1.00	**<0.001**
SEX [M]	1.09	1.04 – 1.14	**<0.001**
ETHNICITY [Asian]	0.63	0.57 – 0.70	**<0.001**
ETHNICITY [African]	0.54	0.44 – 0.66	**<0.001**
ETHNICITY [Mixed or multiple ethnic groups]	1.79	1.53 – 2.08	**<0.001**
ETHNICITY [Other ethnic groups]	0.38	0.30 – 0.46	**<0.001**
ETHNICITY [Arabic]	0.77	0.62 – 0.95	**0.020**
ETHNICITY [Carribean]	1.46	1.24 – 1.70	**<0.001**
SIMD DECILE [2]	0.97	0.91 – 1.02	0.250
SIMD DECILE [3]	0.78	0.71 – 0.85	**<0.001**
SIMD DECILE [4]	0.88	0.80 – 0.96	**0.005**
SIMD DECILE [5]	0.85	0.77 – 0.93	**0.001**
SIMD DECILE [6]	0.94	0.84 – 1.04	0.246
SIMD DECILE [7]	0.83	0.73 – 0.94	**0.003**
SIMD DECILE [8]	0.84	0.75 – 0.95	**0.004**
SIMD DECILE [9]	0.77	0.67 – 0.88	**<0.001**
SIMD DECILE [10]	0.75	0.64 – 0.88	**0.001**
Observations	74383		
R^2 Tjur	0.028		

Model 5: Disease-count and 90-day reattendance (unadjusted)

	90 DAY REATTENDANCE		
Exposures	*Odds Ratios*	*95% CI*	*p*
DISEASE COUNT [1]	2.47	2.36 – 2.59	**<0.001**
DISEASE COUNT [2]	3.50	3.31 – 3.69	**<0.001**
DISEASE COUNT [3]	4.28	3.98 – 4.59	**<0.001**
DISEASE COUNT [4]	6.50	5.87 – 7.19	**<0.001**
DISEASE COUNT [5]	8.64	7.35 – 10.17	**<0.001**
DISEASE COUNT [6+]	10.35	7.92 – 13.62	**<0.001**
Observations	73812		
R^2 Tjur	0.074		

Model 6: Disease-count and 90-day reattendance (adjusted)

	90 DAY REATTENDANCE		
Exposures	*Odds Ratios*	*95% CI*	*p*
DISEASE COUNT [1]	2.41	2.29 – 2.53	**<0.001**
DISEASE COUNT [2]	3.49	3.29 – 3.71	**<0.001**
DISEASE COUNT [3]	4.37	4.05 – 4.71	**<0.001**
DISEASE COUNT [4]	6.68	6.01 – 7.42	**<0.001**
DISEASE COUNT [5]	8.97	7.61 – 10.59	**<0.001**
DISEASE COUNT [6+]	10.71	8.18 – 14.12	**<0.001**
AGE	1.00	0.99 – 1.00	**<0.001**
SEX [M]	1.05	1.01 – 1.09	**0.007**
ETHNICITY [Asian]	0.63	0.58 – 0.68	**<0.001**
ETHNICITY [African]	0.55	0.46 – 0.65	**<0.001**
ETHNICITY [Mixed or multiple ethnic groups]	1.56	1.35 – 1.78	**<0.001**
ETHNICITY [Other ethnic groups]	0.27	0.22 – 0.32	**<0.001**
ETHNICITY [Arabic]	0.80	0.67 – 0.95	**0.011**
ETHNICITY [Caribbean]	1.14	0.98 – 1.31	0.077
SIMD DECILE [2]	0.94	0.89 – 0.98	**0.009**
SIMD DECILE [3]	0.86	0.80 – 0.92	**<0.001**
SIMD DECILE [4]	0.89	0.82 – 0.96	**0.002**
SIMD DECILE [5]	0.81	0.75 – 0.88	**<0.001**
SIMD DECILE [6]	0.86	0.78 – 0.94	**0.001**
SIMD DECILE [7]	0.80	0.72 – 0.89	**<0.001**
SIMD DECILE [8]	0.77	0.70 – 0.85	**<0.001**
SIMD DECILE [9]	0.75	0.67 – 0.83	**<0.001**
SIMD DECILE [10]	0.69	0.60 – 0.79	**<0.001**
Observations	73812		
R^2 Tjur	0.081		

Model 7: Disease-count and inpatient mortality (unadjusted)

	INPATIENT MORTALITY		
Exposures	*Odds Ratios*	*95% CI*	*p*
DISEASE COUNT [1]	2.70	2.26 – 3.25	**<0.001**
DISEASE COUNT [2]	3.41	2.83 – 4.13	**<0.001**
DISEASE COUNT [3]	3.80	3.08 – 4.69	**<0.001**
DISEASE COUNT [4]	2.94	2.18 – 3.92	**<0.001**
DISEASE COUNT [5]	1.95	1.13 – 3.14	**0.010**
DISEASE COUNT [6+]	2.07	0.87 – 4.14	0.064
Observations	29966		
R^2 Tjur	0.008		

Model 8: Disease-count and inpatient mortality (adjusted)

	INPATIENT MORTALITY		
Exposures	*Odds Ratios*	*95% CI*	*p*
DISEASE COUNT [1]	1.84	1.53 – 2.22	**<0.001**
DISEASE COUNT [2]	1.81	1.49 – 2.20	**<0.001**
DISEASE COUNT [3]	1.77	1.43 – 2.20	**<0.001**
DISEASE COUNT [4]	1.30	0.96 – 1.74	0.083
DISEASE COUNT [5]	0.86	0.50 – 1.39	0.557
DISEASE COUNT [6+]	0.98	0.41 – 1.96	0.949
AGE	1.06	1.05 – 1.06	**<0.001**
SEX [M]	1.33	1.17 – 1.50	**<0.001**
ETHNICITY [Asian]	0.59	0.32 – 0.98	0.062
ETHNICITY [Other]	0.51	0.16 – 1.22	0.187
SIMD DECILE [2]	0.79	0.66 – 0.94	**0.009**
SIMD DECILE [3]	1.06	0.85 – 1.30	0.614
SIMD DECILE [4]	0.80	0.61 – 1.04	0.100
SIMD DECILE [5]	0.72	0.54 – 0.94	**0.018**
SIMD DECILE [6]	0.84	0.62 – 1.11	0.231
SIMD DECILE [7]	0.66	0.47 – 0.91	**0.013**
SIMD DECILE [8]	0.68	0.47 – 0.94	**0.027**
SIMD DECILE [9]	0.97	0.69 – 1.32	0.831
SIMD DECILE [10]	0.85	0.55 – 1.26	0.452
Observations	29966		
R^2 Tjur	0.035		

Appendix 15

Group publication on PPI in nursing PhD projects - accepted version

Involving the public in nursing PhD projects: practical guidance, potential benefits, and points to consider

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Involving patients and the public in nursing PhD projects: practical guidance, potential benefits, and points to consider

Abstract

Background

Patient and public involvement is increasingly expected by research funders, academic publishers and research governance bodies. It also allows nurse researchers to increase the visibility of scholarly nursing roles, which are poorly understood by the public. There are different approaches to involvement, and a wealth of guidance on how it can and should be implemented. Less is known about how this should be done in the context of a nursing PhD.

Aim

To discuss the experience of our nursing research group in involving patients and the public in PhD research, to reflect on some of the benefits to be gained from doing so, and to highlight some key considerations for those planning on involving patients and the public in their doctoral research project.

Discussion

Planning ahead about who to involve, how to reach them and why you are involving patients and the public is essential. More accessible documentation, refined methods and better research outputs created in collaboration with patients and the public are some potential benefits.

Conclusion

Patients and the public should be involved in nursing PhD projects. Not only does this improve the quality of the research and raise the profile of nursing research, but it provides the opportunity for students to learn skills which they can further develop throughout their academic career.

Implications for practice

Doing high-quality patient and public involvement is an important skill for nurse researchers, and the first steps to acquiring this skill should be taken in the context of their research training.

Keywords

nurses; nursing; nursing research; PhD; postgraduate research; patient and public involvement

Introduction

Patient and public involvement in health research is increasingly considered good practice (Biddle et al., 2021, Greenhalgh et al., 2019). Involving people with lived experience of the research topic can improve measurable outcomes such as recruitment (Crocker et al., 2018), and generate qualitative improvements such as making a project more relevant to patients (Crocker et al., 2017). Patients who are involved in the development of research report feeling more valued, confident, and knowledgeable about their health (Brett et al., 2014).

Nurses are well-placed to engage patients and the public in research (Fletcher et al., 2021), and doing so can be of value to the nursing profession. Public perception holds nurses in an incongruous position of being both well-trusted and poorly-understood (Girvin et al., 2016). The onus for improving how nursing is understood is placed on the profession itself, with an expectation that nurses (particularly those in scholarly or strategic positions) make themselves and their roles more visible (Hoeve et al., 2014). Approaches which capitalise on the profession's trustworthiness to raise its profile seem prudent. As nurse researchers, we can do this is by consulting and collaborating with patients and the public in the design, development and conduct of our research.

Patient and public involvement can take many forms, and the National Institute for Health Research (NIHR) in the UK provides comprehensive guidance for researchers. The NIHR (2021) classify involvement using three definitions of relevance to this article:

- Consultation: asking members of the public about specific issues related to their research, often as a one-off meeting.
- Collaboration: an ongoing relationship and shared ownership over most decisions.
- Co-production: sharing the responsibility for decisions and generation of new knowledge equally between researchers and contributors from beginning to end of the project.

The UK Standards for Public Involvement (UK Public Involvement Standards Development Partnership, 2019) are a further resource, and are structured around six domains: inclusive opportunities, working together, support and learning, governance, communications, and impact. There are also implementation stories which provide examples of how the standards were integrated into research projects across the UK (UK Public Involvement Standards Development Partnership, 2020). However, many different frameworks for supporting involvement exist and researchers will need to tailor guidance to suit their unique circumstances (Greenhalgh et al., 2019).

One's approach to patient and public involvement will depend on several factors, including funding, available time, and researcher experience. While the influence of these factors will be felt keenly by nurses undertaking their PhD, we believe that it is an important skill to acquire at this formative stage in a researcher's career. Such involvement comes with unique challenges, but can also be an enriching experience for both the student and contributors (Dawson et al., 2020). Furthermore, given the focus placed on avoiding 'tokenism' (Ocloo and Matthews, 2016), we emphasise that involving patients and the public in nursing PhD projects is an important part of research training and can help students learn how to avoid such tokenism (Troya et al., 2019). Setting such standards at the outset of one's research career should be a statement of intent, signalling a commitment to meaningful engagement which will grow with experience.

In this article, we aim to discuss the experience of our nursing research group in involving patients and the public in PhD research, to reflect on some of the benefits to be gained from doing so, and to highlight some key considerations for those planning on involving patients and the public in their doctoral research project.

The research group

The Palliative, End of Life and Bereavement Care studies group at the University of Glasgow's School of Medicine, Dentistry and Nursing comprises a team of nurses from a wide range of clinical backgrounds and from several countries. The group share a common goal to improve the way nursing care is provided to people with life-limiting and palliative conditions, and the bereaved friends and relatives of such persons.

Table 1 provides an overview of the projects.

Name	PhD topic	Number of contributors	Eligibility criteria	Recruitment methods	Contact methods	Influence of contributors on research
CM	Development of a nurse led intervention for people with multimorbidity	12	• Living with ≥2 chronic conditions, or caring for someone with ≥2 chronic conditions	• Social media • Online newsletter	• Email • Video calls • Messaging apps • Telephone • Post	• Manuscript proofed and redrafted with comments from contributor. • Ethnography documentation developed and reviewed with input from contributors. • Methods adapted including more use of technology, better support for people with impaired communication, addition of researcher pictures to information sheets.
BA	To explore the impact of culture on palliative care for people with advanced heart failure from diverse backgrounds	4	• Living with heart failure or caring for someone with heart failure, **and** • Belonging to one of the targeted cultural groups	• Face-to-face through cultural and social events and meeting places	• Mostly face-to-face • Email, video calls and messaging apps during covid lockdowns	• Guidance on suitability of methods • Disseminating findings through cultural networks. • Analysis of qualitative data.
MD	To develop an intervention for caregivers of people with life-limiting conditions.	3	• Caregivers of people living with life-limiting conditions	• Structured patient and public involvement event at host university • Social media	• Face-to-face meetings with primary contributor • Telephone with secondary consultants • Video calls and email during covid lockdowns	• Lived experience of primary contributor helped direct inquiry towards differences between male/female caregivers • Refined data collection method for focus groups • Contributed to validation and identification of themes in qualitative data
AF	To explore the effects of patient online self-diagnosis and health information-seeking on the patient-healthcare professional relationship and medical authority.	2	• People who have used the internet to self-diagnose or look up health information, particularly for heart failure and cardiac conditions	• Social media • Networking at a digital health conference	• Face-to face • Video calls during covid lockdowns	• Informed research questions and data collection tools • Reviewed ethics submissions, manuscripts and participant-facing documents. Recommended inclusion of researcher photo on information sheets
CP	To evaluate an existing palliative care service and develop a nurse led intervention for people with	3	• One person with cancer • One person caring for someone with cancer • One nurse working with	• Social media	• Video calls • Email • Occasionally face-to-face	• Provided contextual information on their lived experience in relation to cancer which influenced the questions asked in qualitative study.

	cancer and their families in Indonesia.		people with cancer			
MS	To explore the symptoms associated with heart failure and the influence of personal and clinical factors on these symptoms.	5	• Living with heart failure or caring for someone with heart failure • Healthcare professionals working with heart failure in Turkey	• Social media • Turkish nurses were reached through contacting cardiovascular clinics in Turkey	• Email • Video calls • Face-to-face for local contributors	• Providing context on heart-failure symptom experience which influenced design of studies • Reading and commenting on manuscripts. • English and Turkish speakers reviewed participant information sheets and helped to ensure that they retained meaning when translated.
ST	To examine symptom burden and caregiver burden in people undergoing palliative radiotherapy and their caregivers	2	• Living with advanced lung cancer or caring for someone with advanced lung cancer	• Social media • Structured patient and public involvement event at host university	• Mostly face-to-face • Social media, video calls and email during covid lockdowns	• Reviewed questionnaires and helped improve accessibility

Table 1: Project summaries. All projects were undertaken by nurses with a range of clinical backgrounds and from several countries.

Key questions to consider when involving patients and the public in doctoral research

In this section we will outline some of the practical considerations faced by the group, and the key questions to ask before engaging in patient and public involvement.

Who should you involve in your PhD?

PhD programmes may comprise several phases with differences in the characteristics of individuals being recruited to each, so it is important that contributors can provide relevant insight for each phase. CM, MD and MS retained contributors with lived experience of the research topic for the duration of their PhDs but supplemented this with short-term input from larger groups assembled to support specific phases. CM's research focusses on people with multimorbidity (≥2 chronic conditions) and includes a study where it was important to gain insight from people with a wide range of conditions including dementia and other cognitive impairments. Therefore, an 11-person group was convened to ensure documentation and processes were accessible. MS collected data in Turkey but required ethical approval to do so from institutions in both Scotland and Turkey. Therefore, contributors were recruited in both nations to ensure documentation was clear in both languages and that meaning was retained in translation.

How will you identify and recruit contributors?

Identifying suitable people requires the nursing PhD student to go out into the places where potential contributors meet, both physically and online (NIHR, 2021). This can require both targeted and ad-hoc methods. For AF, a chance encounter with a patient advocate at a digital health conference led to their involvement in AF's PhD, which sought to explore the concept of online self-diagnosis and health-information seeking behaviours. A structured patient and public involvement event at the University provided opportunities for MD and ST to recruit contributors. Both approaches yielded contributors who were enthusiastic about the research topic and about patient and public involvement

Finding contributors may require searching beyond the online space. BA's research focusses on the relationship between culture and heart failure, therefore he sought to recruit contributors from diverse cultural and ethnic backgrounds. To do this, BA attended social events and spaces where people from the targeted cultural groups met, and through establishing rapport and integrating with these groups he was able to recruit contributors. Accessing these tight-knit relational networks organised by ethnicity, religion or immigration status required a physical presence and for BA to gain the trust of those he wanted to speak with.

How will you keep in touch and maintain a good relationship?

Involving someone in a nursing PhD research programme can mean that they will be involved for several years, particularly if it is being done part-time alongside clinical practice. This is a significant commitment, and it is important to agree how you will communicate throughout the project and to be clear about expectations. The UK Standards for Public Involvement emphasise the importance of *working together*, by clearly defining roles, responsibilities, expectations and ways of working so that everyone's contribution is valued (UK Public Involvement Standards Development Partnership, 2019). Working in partnership with patients, valuing their contributions and communicating effectively are core components of nursing care (Nursing and Midwifery Council, 2018), and are skills which can be further developed in the context of a nursing PhD.

Both face-to-face and remote approaches have strengths and weaknesses, but the unifying strength is that the approaches to communication used throughout the various projects were agreed with contributors at the outset. In the preceding section we outlined how BA's relationship with contributors required him to see them face-to-face; for CM the opposite was true. Participants had multiple chronic conditions and most of CM's research was conducted during the covid-19 pandemic, during which time many such individuals were self-isolating. As a result, CM's contributors were recruited remotely, and communication took place over email, telephone or videoconferencing. Once restrictions were lowered, this arrangement still suited contributors and therefore was maintained throughout the project.

How will you reimburse contributors?

People who give their time to help with research should be reimbursed for doing so. Yet how this is done depends on several factors, including the level of involvement, time spent, and whether they will incur any direct costs (such as travelling expenses). It is important to consider what impact reimbursement can have on contributors who receive benefits. The NIHR recommends developing a payment plan which explains how much contributors will be paid, how they will be paid, and how they can avoid potential barriers related to benefits, for example by declining payments or requesting lower amounts (NIHR, 2022).

We communicated in our initial contact that we would reimburse participants for their time using shopping vouchers for high-street and online retailers. When contributors were helping with a specific task (such as reviewing documentation) they were reimbursed with a £20 voucher for each task (assuming around one hour of time spent on the task). Out-of-pocket expenses were reimbursed promptly or paid in advance. For face-to-face meetings, going to a café and buying tea or coffee is a small gesture but can help show appreciation for the contributor's time. MS had local contributors, and she would arrange lengthier meetings over lunch and pay the bill.

Costs are ultimately dependent on the type and level of involvement required. For example, having one or two contributors to consult with at the start of your research will cost significantly less than it would to have a patient and public steering group for the duration of the project, or to convene a focus group to co-design data collection tools. Pizzo et al. (2015) conducted an economic analysis of the cost and effects of patient and public involvement, concluding that while there are many benefits there is less clarity about how much it costs. We must consider not only the monetary costs (such as materials and expenses), but also the non-monetary costs (such as the time cost to contributors) (Pizzo et al., 2015).

Building costs into grant applications helps prevent future issues with reimbursement and communicates to the funder that you intend to conduct research which matters to patients. However, these costs may not have been accounted for in a funded nursing PhD. Tomlinson et al. (2019) described how they applied for a small NIHR grant to fund patient and public involvement in their PhD projects. Our group had access to a small patient and public involvement grant held by our primary supervisor. Grants for this purpose can occasionally be found; we recommend checking the websites of major funders such as the Medical Research Council and NIHR, alongside relevant charities. Supervisors may also be able to highlight internal funding opportunities. If the costs are expected to be low for individual students, applying for a small grant as a research group may be more appropriate.

How much time can you dedicate to involvement?

Coordinating involvement activities can take a lot of time, and it is best to over-estimate how long each activity will take. Initial meetings can be lengthy, as these involve establishing rapport and agreeing how to proceed. For MD, the first two meetings with her primary advisor lasted 2-3 hours each, although this cemented a strong, mutually beneficial relationship which lasted throughout the project. Collaboration and co-production are particularly time-consuming, but even if only consulting patients and the public about your research, it is important to allow them plenty of time to think and to read any materials you have shared (NIHR, 2021).

How much experience do you and your supervisor(s) have involving patients and members of the public in research?

There is good reason to argue that all patient and public involvement should strive towards partnership working (for example co-production) and avoid tokenistic approaches (Ocloo and Matthews, 2016), and this argument is framed against the fact that often such involvement comprises consultation and occasionally collaboration in the early stages of a project, with little ongoing input from contributors (Pii et al., 2019). However, co-production requires that contributors are afforded the same ownership over decisions as the researcher (NIHR, 2021), and there are ethical dimensions to be considered when embarking on this approach (Reddy and Ghosh-Jerath, 2021). PhD students should consider the level of experience they (and their supervisory team) have in this area. For many nurses embarking on a research career, this will be their first sizeable project and attempting co-production may be overambitious. As we have demonstrated throughout our projects, there is scope to collaborate with patients and members of the public throughout the entirety of the research, such as BA involving collaborators in the analysis of interview transcripts, MD developing themes with her contributor, or several of the group's assistance in designing data collection tools. Limited experience shouldn't prevent collaboration or restrict students to tokenistic approaches, but it is important to also be realistic about what can be achieved in your PhD. As clinical nurses we are required to practice within our level of competency (Nursing and Midwifery Council, 2018), and the same standards should apply in how we conduct our research.

What do you want to achieve by involving patients and the public?

Patient and public involvement is often used to set the agenda of research (Price et al., 2018), but for most nurses undertaking a PhD this will already have been agreed at the outset. In the next section we outline some benefits to involving patients and the public in PhD research. But another area which should be considered is how engaging with contributors from a target population can help students to understand the nuances of its culture.

In this context, culture is not limited to geographically close or demographically homogenous groups, but rather the shared norms and beliefs held by disparate groups with a common experience, such as living with a chronic condition (Morse, 2014). Several of our group reported this benefit, although it is difficult to quantify. In a separate project undertaken by members of our group (included as an exemplar in the UK Standard for Public Involvement's implementation stories (UK Public Involvement Standards Development Partnership, 2020)), we explored palliative care for people in prison. It was through holding patient and public involvement groups in the prison with incarcerated men that we were able to uncover unique challenges which would otherwise have frustrated our attempts to collect data. While involvement may require time, funding and expertise, it is important to remember that it can play a significant role in ensuring that a project proceeds as planned, and that it generates findings which matter to patients.

Improvements resulting from patient and public involvement

Having considered the key questions related to patient and public involvement in nursing PhD projects, we will now outline some of the ways patients, the public and researchers can benefit from involvement.

Patient-friendly documentation and approaches

Contributors often helped to make patient-facing documentation (such as information sheets and consent forms) more comprehensible. Nursing PhD students can take simple steps such as using plain language and keeping documents succinct, but ultimately each target population may have specific needs which can only be met if contributors are involved in producing documentation.

Some of CM's contributors experienced complex barriers to communication. These contributors helped improve documentation and processes, such as by producing large-text documentation, providing audio recordings of the documents being read aloud, and ensuring that consent could be provided with a witness present. People experiencing cognitive impairment requested a picture of the researcher on the documentation so that they would be able to remember the person they were dealing with (also requested by AF's contributors). Others who were registered blind made use of electronic reading software and were able to identify aspects of the documentation which did not work when read electronically.

MS faced the challenge of developing materials in both English and Turkish language versions, which had to be appropriate for rural and urban populations with variable literacy. To resolve this, contributors who were Turkish speakers, some who were bilingual and some with lower literacy were recruited. The resulting documentation was not only more accessible to the target population, but through the involvement of bilingual speakers it became possible to check that the Turkish versions were congruent with the English-language study protocol and research questions.

More effective methods and better study design

Contributors were also able to advise on methods and study design. Often this was through refining researcher-designed data collection tools, as was the case for CM, MD, AF and ST.

BA's qualitative focus group study was significantly strengthened due to the input of contributors. Initial recruitment was hampered by difficulties accessing some cultural groups, and piloting of focus group topic guides did not generate the depth of data anticipated. Contributors supported the research team by acting as 'cultural brokers'. Through discussion with the contributors, BA and the research team reoriented the topic guide to approach the subject more obliquely, using scenarios. This approach allowed participants to engage with sensitive subjects in a way they had felt unable to when approached directly.

Sharing ownership of findings

Contributors were often involved in producing reports – including manuscripts for submission to academic journals. The motivations for this are different to involving patients in the production of patient-facing documentation, as the majority readership of academic papers is other researchers and clinical staff. However, involving patients and the public in reviewing such materials can provide a useful sense-check, as the potential readers of a manuscript may not possess the same degree of subject knowledge as the author. Contributors in our group were often able to identify gaps in how we contextualised our research, or challenge assumptions. For both BA and MD, their long-standing primary contributors helped to validate and identify themes in their qualitative data, providing reassurance that their interpretation was accurate.

The most important motivator for involving patients and the public in this process, however, was to ensure that those who had contributed to earlier stages in the research process retained ownership over how the findings were disseminated. It is important to follow the International Committee of Medical Journal Editors' (ICMJE) guidance (ICJME, 2022) when determining whether a contributor should be considered an author. If this is not the case, it is still important to thank and acknowledge contributors for their help in the same way as any other non-author collaborator.

Challenges and lessons learned

Despite the many benefits to be gained from patient and public involvement, we should also note that it requires commitment and can include challenges. A PhD can last a long time and circumstances can change. Some of our contributors had to withdraw their support prematurely, due to worsening health, bereavement, or work and family commitments. Some of us struggled to recruit enough contributors. In some cases, processes expected to take a few days (such as reviewing documentation) lasted weeks, impacting on project timescales.

It is important to acknowledge such challenges, because these (and many others) have informed the recommendations made in this article. As with any other research activity, patient and public involvement does not always go to plan. As nurses we must reflect on and learn from these instances, sharing what we have learned so as to improve how we as a profession approach patient and public involvement in research.

Conclusions

Involving patients and members of the public throughout the research process is an essential skill and one which should be introduced to nurse researchers at an early stage in their careers. Patient and public involvement in a PhD project has its challenges, but these can be overcome with careful planning and adaptability. Factors such as time, funding and researcher experience will influence what approach is taken, as will the intended goals of involving patients and the public. It is important to decide which level of involvement (i.e. consulting, collaborating, co-production) is best suited to you, your project, and your supervisory team. Doing this effectively not only provides better outcomes for the nurse undertaking their PhD, but fosters a more patient-oriented approach to research which can continue throughout a nurse's research career.

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