AN EPIDEMIOLOGICAL STUDY OF FLEXNER DYSENTERY IN GLASGOW.

by

OLADIPO OLUSENGUN HUNPONU - WUSU.

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S U M M A R Y

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Flexner dysentery is world-wide in distribution. In the developing countries the disease is a major cause of morbidity and mortality but in the developed countries, where mortality from it is negligible, morbidity is still significant and there are problems still to be overcome before flexner dysentery can be eradicated or even completely controlled.

The objectives of this thesis were to investigate the medico-social aspects in the epidemiology of the disease and to elicit any aetiological factors for its incidence in Glasgow where over the past fifty years it has persisted on a higher level than anywhere else in the United Kingdom.

Chapter I reviews the relevant literature on the history of the dysenteries which can be appropriately divided into two periods. The first period culminates in the discovery of Amoeba coli in 1875 and the second period, from 1875 onwards, covers the aetiological differentiation of the various types of bacillary dysentery. The systematic nomenclature and taxonomy of these intestinal pathogens is now undertaken by the Enterobacteriaceae Subcommittee of the International Association of Microbiologists and the various Shigella Centres established throughout the world.

In Chapter II the epidemiology of bacillary dysentery is critically appraised. The incidence of sonne dysentery in the United Kingdom by far outnumbers that of flexner and all other types of bacillary dysentery. In consequence the epidemiology of sonne is well documented but specific refer-

ence to that of flexner is scanty and thus although there are many factors common to both diseases this deficiency has to be recognised in any attempt to elucidate the epidemiology of flexner dysentery.

Bacillary dysentery in the United Kingdom is mainly a disease of children occurring throughout the whole year but especially in winter. It is associated with the lower social classes and wherever there is defective hygiene and sanitation. Transmission is by "anal oral spread". Occasional outbreaks are due to contaminated food, milk and water supplies but its incidence is not related to frequency of fly infestation. From this review however there appears no outstanding epidemiological differences between flexner and sonne dysentery but the severity of illness in flexner infection is usually greater.

Chapters III to V which describe accounts of the field work personally undertaken include two series of investigations - a retrospective study and a prospective survey.

The retrospective study, Chapter III, involved detailed analysis of the incidence of bacillary dysentery in Glasgow in relation to notifications and bacteriological isolations by serological type and the findings are studied against the background of the incidence in Scotland and in the United Kingdom as a whole. The level of notification for various reasons outlined is by no means an accurate index of the incidence of the disease. Notification rates however reveal that over the past fifty years the highest incidence of bacillary dysentery in Scotland and also in Glasgow was in the 1954 to 1958 quinquennium. The highest annual notification rates were in 1956 when the rates

per 100,000 population were 240 in Scotland and 687 in Glasgow respectively. The retrospective study also shows that, in respect of all bacteriologically confirmed isolations from hospital and domiciliary patients for the quinquennium 1962 to 1966, Glasgow had a greater proportion of Shigella flexneri than the averages for Scotland and for the whole of the United Kingdom. For every 100 isolations of Shigella sonnei there were 20 to 56 isolations of Shigella flexneri in Glasgow, 3 to 25 in Scotland and only 1 to 3 in the United Kingdom. In comparison with other cities, for every 100 isolations of Shigella sonnei there were 39 isolations of Shigella flexneri in Glasgow, 14 in Birmingham and only 0.6 in Liverpool.

Chapter IV describes the material and methods used in the prospective survey which was preceded by a pilot investigation.

The prospective survey consisted of an epidemiological study of 360 patients - 132 with flexner and 228 with sonne dysentery - admitted to the two infectious diseases hospitals, Belvidere and Ruchill, during the period April to November 1968. Patients with flexner dysentery were regarded as the "Case and contrasted with those suffering from sonne dysentery - the "Controls"-in an attempt to distinguish any differing epidemiological factors.

The results, Chapter V, are considered under the headings, demographic data, housing circumstances, incidence of diarrhoea in households, "Cases" and their contacts, and resistance of organisms to antimicrobial drugs.

The majority of patients were children and the housing circumstances of most flexner patients were grossly inadequate in toilet facilities. Such unsatisfactory housing and living conditions are conducive to the existence and

spread of flexner dysentery and probably contribute largely to the high incidence in Glasgow. Municipal ward distribution indicates that flexner dysentery is localised in some wards but that sonne dysentery is widely scattered through out the city. The introduction of flexner dysentery from sources outside Glasgow does not account for the high incidence of the disease therein but convalescent carriers with a history of previous hospitalisation constitute an important reservoir of infection. The cost of hospitalisation of the 360 patients in the present survey was almost forty thousand pounds and social, as distinct from medical reasons, accounted for the admission of 41% of flexner and 46% of sonne patients.

Antimicrobial drug resistance patterns and their possible significance in the epidemiology of flexner dysentery are fully investigated. In Glasgow individual antimicrobial drug resistance of Shigella is commonest to sulphonamides and then to streptomycin, tetracycline, ampicillin and cephaloridine respectively. Multiple resistant strains are a cause for concern particularly those of Shigella flexneri serological type X where one in every five strains was found resistant to seven drugs but no relationship between multiple resistant strains and previous hospitalisation, municipal ward distribution, or age of patient could be established. In the survey none of the 360 strains of Shigella was resistant to nalidixic acid and this drug appears from in vitro and in vivo studies to be the one of choice for the treatment of bacillary dysentery in Glasgow.

O. O. HUNPONU-DUSU,

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OUTLINE OF THESIS

VOLUME I

VOLUME II

CONTENTS

INTRODUCTION

In the developing countries such as my own - Nigeria - the prevention, control and treatment of the communicable diseases form an integral part of the work of the health services and much energy and resources, often with the aid of the World Health Organisation, are devoted to their eradication. Attempts have been made to evaluate whether a primary objective of the health services in these countries should be devoted to the prevention of communicable diseases rather than to emphasis on developing the curative facilities. There is no doubt that the prevention and effective control of these diseases would contribute more than any other medico-social factors to the economic viability of such countries if only for their effect in reducing morbidity and mortality. To this end, national and international schemes of eradication for such diseases as smallpox, tuberculosis, leprosy and cholera have been undertaken throughout the world in the past decades.

In the developed countries, where most of the infections which were formerly major causes of morbidity and mortality have disappeared, the attention of many health workers is nowadays focussed increasingly on the epidemiology of the non-communicable diseases such as

the cardiovascular diseases, the neoplasms, the mental and the metabolic disorders. Nevertheless even in these countries, there are still some problems to be overcome in the eradication of communicable diseases. In the United Kingdom itself diarrhoeal diseases still show a high annual incidence. Throughout the past fifty years, bacillary dysentery has been prevalent in Scotland and in Glasgow, a city of just under one million inhabitants with two major infectious disease hospitals, flexner dysentery has been constantly present.

Thus, it was considered that an epidemiological study of flexner dysentery in Glasgow was desirable to try and elicit possible reasons for this relatively high incidence and also to gain experience from the planning, organisation and field work to carry out similar studies in the prevention and control of the major communicable diseases prevalent in the writer's own country.

OBJECTIVES

1. To investigate the medico-social aspects of the epidemiology of flexner dysentery.

2. To seek aetiological factors for the high incidence of the disease in Glasgow.

CHAPTER I

A HISTORY OF THE DYSENTERIES

A. HISTORY OF DYSENTERY BEFORE 1875

B. HISTORY OF DYSENTERY AFTER 1875

1. The differentiation of Amoebic dysentery
2. The differentiation of Bacillary dysentery
   - (a) Kiyoshi Shiga
   - (b) Simon Flexner
   - (c) Carl Olaf Sonne
   - (d) Karl Eitel Friedrich Schmitz
   - (e) John Smith Knox Boyd
3. The definitions of Enterobacteriaceae and Shigella
4. The classification of the Shigella group

INTRODUCTION

It is appropriate to divide the history of the dysenteries into two periods, pre 1875 and post 1875. The first period culminated in the discovery of Amoeba coli in 1875 and the second period after 1875 includes the aetiological differentiation of the types of bacillary dysentery.

A. HISTORY OF DYSENTERY BEFORE 1875

The term "dysentery" is derived from the Greek word, δυσ-εντερία meaning a bowel complaint. From the earliest times, reference has been made to bowel complaints.

In the Bible, Job in his lamentations remarked -

> "Behold, O Lord; for I am in distress;
> my bowels are troubled."
>
> Lamentations 1, 20.

> "My liver is poured upon the earth."
>
> Lamentations 2, 11.

According to Castellani and Chalmers (1919) the term dysentery was first employed by Hippocrates, the Father of Medicine, in the 4th century B.C. He recognised two distinct types of disease of the bowels, one characterised

by the number and fluidity of the motions which he called διάρροια diarrhoea, and the other by the presence of blood in the motions which he termed, δυσ-εντερία dysentery. Hippocrates also observed that bloody diarrhoea was often accompanied by tenesmus and abdominal pain.

Originally the term "dysentery" included any disease in which there was a discharge of blood from the anus, but several of the ancient physicians, Celsus, Aretaeus, Archigenes and Galen, whilst stressing the importance of the presence of blood and mucus in the motions, also distinguished clinical features of the disease. Celsus believed that dysentery was due to intestinal ulcers which caused the patient to suffer from pain and tenesmus. Aretaeus, the Cappadocian, associated the site extent and degree of these ulcers with intestinal haemorrhage and pointed out the severity of the clinical features arising from these haemorrhages.

From the 5th century onwards, epidemics of dysentery were noted in Europe. Allbutt (1921) reported that dysentery was well known in Greek and Roman eras and continued in Western Europe all through the Middle Ages. It occurred in France in A.D. 534 and A.D. 538 and again in Northern Europe in A.D. 760. Although these outbreaks persisted through the Middle Ages, it was not until 1646

that further progress on the nature of the disease was made.

According to Manson-Bahr (1943) the infectious nature of dysentery was first referred to by Fabricius Hildanus in 1646. Subsequent observers were impressed with the pandemic nature of the outbreaks. Dysentery occurred in France from 1749 to 1750 and in 1759 especially in the Central and Southern provinces; in Belgium in 1831 and in Luxemburg in 1863.

Dysentery was widespread in Germany. Between 1676 to 1678, it occurred in Saxony and the Rhine Provinces and from 1726 to 1728 in Silesia, Saxony and the Mark of Bradenburg. In Sweden, between 1649 to 1652, dysentery raged over nearly the whole country and later between 1770 and 1775 in nearly every province. Similar pandemics occurred in the Southern districts of Norway between 1808 and 1810.

Britain has had her share of pandemic dysentery. According to Creighton (1891) two outstanding pandemics have occurred, the first from 1539 to 1540 and the second between 1780 and 1785. In the 16th century, the English names used for dysentery were flux and lask. At that period, lasks or lienteries or dysenteries were associated with famine sicknesses. Creighton reports that in 1540,

there was a "great lask throughout the realm" associated with "strange fevers".

Pandemic dysentery again occurred in England between 1779 and 1785. This second outbreak was prevalent in London in the autumns of 1779, 1780 and 1781. A high mortality resulted from the outbreak and dysentery was regarded as "a fatal malady". In subsequent years, outbreaks of dysentery occurred throughout England. Widespread epidemics also occurred in Scotland - in Glasgow in 1827 and in Edinburgh in the following year.

Dysentery has been reported to break out as a consequence of war. Heredotus in 380 B.C. attributed the defeat of the Persian Army partly to dysentery. Since that time, dysentery has been recorded as an important scourge of military campaigns. Many instances of epidemics occurring in wartime are cited by Manson-Bahr. The Napoleonic Wars 1790 to 1815, the Crimean War 1854 to 1855, the Franco-German War 1870 to 1871, the Russian-Turkish War 1878 to 1879, the English Campaign in New Zealand 1860 to 1861, the War of Secession in the United States, have all shown the extensive spread of dysentery during wartime. In support of these observations, Shiga at a later date stated that dysentery was always a constant companion of war and was more fatal to armies than powder or shot.

In some countries, famine has played an important part in contributing to the spread of dysentery. Famine consequent on the failure of crops was responsible for dysentery in Ireland in 1806, 1817, 1821, 1826, and 1846 to 1847; for outbreaks in Tobolsk Russia in 1863, and in Gambia Africa from 1853 to 1855 (Manson-Bahr 1943).

Throughout the period before 1875, other observers have reported on different aspects of dysentery. Sydenham, describing an epidemic from 1669 to 1672, differentiated clearly the macroscopic appearance of the stools of patients with dysentery and pointed out that although they often contain blood and mucus, blood is sometimes absent.

Pringle (1752), reporting outbreaks of dysentery in the English Army, realised that epidemic dysentery was a single entity of an infectious nature transmitted by the discharges of the patient. Cleghorn (1779), who gave an account of dysentery in the English Navy in Minorca and who described the symptomatology of the dysenteries, recommended the early institution of therapy to prevent many fatal cases.

According to Manson-Bahr (1943) the clinical varieties of dysentery were described by Zimmerman in 1767 and later, in the early 19th century, the pathological processes were described by Rokitansky and Virchow.

Thus up until 1875, dysentery was recognised only in clinical terms and whilst its infectious nature, its epidemic and pandemic appearances were described, the aetiology of the disease was still unknown.

B. HISTORY OF DYSENTERY AFTER 1875

1. THE DIFFERENTIATION OF AMOEBIC DYSENTERY

Although Lambl working in Prague in 1859 found living amoebae in a case of infantile diarrhoea and subsequently demonstrated amoebae in other cases of dysenteric diarrhoea, he was doubtful if these amoebae were pathogenic in nature.

According to Scott (1942), the first major advancement on dysentery came in 1875 with the work of Lösch who in 1875 at St. Petersburg, found amoebae in the stools of a Russian peasant named Markoff who had come from Archangel to seek employment at St. Petersburg. Lösch described the size, appearance and character of the nuclei of these amoebae and was able to infect a dog with fresh stools from this patient. Lösch called this organism Amoeba coli.

Manson-Bahr (1943) states that Robert Koch discovered amoebae in sections of dysenteric ulcers and from the wall of a liver abscess in 1833. In 1886, Kartulis in Egypt discovered amoebae in the stools of patients with dysentery and subsequently in pus from liver abscess and thus demonstrated the association between tropical dysentery and abscess of the liver.

In 1890, William Osler, working at Johns Hopkins Hospital in Baltimore, United States, confirmed the presence of amoebae in the stools of patients with chronic dysentery which had been contracted in the Panama region and also found amoebae in the pus of their liver abscesses. In the following year and from the same hospital, Councilman and Lafleur extended further the work of Osler. They distinguished the harmless Amoeba coli from the organism causing the disease which according to Rodgers (1913) they then called "Amoeba dysenteriae". At a later date, Schaudinn traced the life history of the human intestinal amoebae and clearly distinguished the non-pathogenic Entamoeba coli from the pathogenic Entamoeba histolytica, which were respectively the organisms amoeba coli and the organism of amoebic dysentery previously described by Councilman and Lafleur.

Up until this period, all the dysenteries were regarded as tropical or amoebic dysentery due to protozoan infection but further progress was made in 1898 when Kiyoshi Shiga working in Japan isolated the dysentery bacillus and so differentiated for the first time the two main types of dysentery now known as AMOEBIC and BACILLARY.

Thus there was an interval of twenty-three years between the time when Lösch in 1875 found amoebae in the stools of patients suffering from amoebic dysentery and 1898 when Shiga isolated the dysentery bacillus. During this period, it was popularly believed that all the dysenteries, especially those occurring in tropical or subtropical countries, were amoebic in origin and it was still not fully recognised that bacillary dysentery was the more widespread and important of the two types.

2. DIFFERENTIATION OF BACILLARY DYSENTERY

The aetiological differentiation of the main types of bacillary dysentery has been accomplished in different countries throughout the world through the efforts of many persons including Shiga, Kruse, Flexner, Strong, Musgrove, Lentz, Duval, Schmitz, Castellani, Andrewes, Hiss, Murray and Boyd. Paramount among these workers are Shiga, Flexner, Sonne, Schmitz and Boyd and a brief description of their relevant discoveries in this field is now given.

(a) Kiyoshi Shiga (b. 1870 d. 1957)

The initial elucidation of the bacteriology of bacillary dysentery is due to the investigations in Japan of Kiyoshi Shiga. While working on

epidemic dysentery in 1898, he discovered as a distinct species of the coliform group of organisms, the bacillus now called Shigella dysenteriae type 1, but originally named B. dysenteriae Shiga. He demonstrated that the serum of patients suffering from dysentery was agglutinated by this bacillus. In 1900, Kruse working in Germany confirmed Shiga's findings and in consequence Shigella dysenteriae type 1 was known on the Continent as the Shiga-Kruse bacillus.

(b) Simon Flexner (b. 1863 d. 1946)

In 1900, Simon Flexner who was then a member of the Commission sent out by Johns Hopkins University to study the diseases prevailing in the Philippine Islands reported the discovery of a bacillus closely resembling Shiga's. Strong and Musgrove working in Manila also discovered a similar organism in 1900. Flexner found that the bacillus which he isolated had distinct agglutinating properties but it was different from that of Shiga's in its power to ferment mannitol.

Lentz confirmed Flexner's findings in 1902 and his work on the sugar reactions of the dysentery bacilli served to divide the dysentery bacilli into

two groups:

1. The non-mannitol fermenters later called the Shiga or the Shiga-Kruse group and
2. The mannitol fermenters, called the Flexner group.

(c) Carl Olaf Sonne (b. 1882 d. 1948)

Sonne's bacillus was first reported by Kruse in 1900 and had been called by him the lactose-fermenting or the E race of pseudo-dysentery bacillus. In 1904 a lactose fermenting bacillus was found by Duval in the United States but nevertheless it was not until 1915 that Carl Olaf Sonne by his studies clearly defined this organism which was called by some observers the Sonne-Duval bacillus but is now commonly known as Shigella sonnei. According to Bojlen (1934), Sonne isolated these bacilli in 35 cases of dysentery occurring in different parts of Denmark between 1911 and 1913 and demonstrated that they formed a well-characterised group of dysentery bacilli which were sharply distinct from those of the Flexner group.

(d) Karl Eitel Friedrich Schmitz (b. 1889 -

While working in Roumania in 1917, Schmitz first isolated an organism which resembled Shiga's bacillus by its inability to ferment mannitol but which fermented rhamnose. This bacillus was called Schmitz bacillus and has since been recognised by various workers including Murray (1918) and Evans (1938). It is now classified as Shigella dysenteriae type 2.

(e) John Smith Knox Boyd (b. 1891 -

Brigadier Sir John Smith Knox Boyd has devoted many years to the study of bacillary dysentery. He carried out extensive bacteriological investigations during his service in the Royal Army Medical Corps in India and submitted to the University of Glasgow in 1947 as his M.D. thesis, "The Mannitol-fermenting group of dysentery bacilli". The results of his investigations on these organisms were published between 1931 and 1946 in a series of papers in different journals and were included as annexures to his thesis. In one of these papers "The laboratory diagnosis of bacillary dysentery", Boyd classified the mannitol fermenting dysentery bacilli into two groups:

1. One group which includes types with specific and group antigens, called B. dysenteriae Flexner, and

2. The other group which has a type specific antigen but no group antigen, called B. dysenteriae Boyd. Boyd himself suggested the name B. dysenteriae India for this latter group, but on the recommendation of Major General Perry, the Society of Tropical Medicine and Hygiene accepted the name B. dysenteriae Boyd in honour of him. These bacilli are now referred to as Shigella boydii.

3. THE DEFINITIONS OF ENTEROBACTERIACEAE AND SHIGELLA

Until comparatively recently, detailed studies of each species of dysentery bacilli have been undertaken by observers working from different viewpoints and this has led to the same organism being ascribed to different groups or classifications and given different names in different countries.

In 1930 the First International Congress of the Association of Microbiologists was held in Paris. An International Committee on Bacteriological Nomenclature

and Taxonomy was inaugurated and its Enterobacteriaceae Subcommittee has since given a uniform classification and nomenclature to the coliform bacilli. The Enterobacteriaceae Subcommittee formed a Shigella Commission in 1947 and in 1951, the Commission recommended that the name Shigella be adopted as the generic name of the group of intestinal bacteria commonly known as dysentery bacilli and that the synonyms bacillus dysenteriae and bacterium dysenteriae be discarded. It was later recommended that the genus Shigella or the Shigella group be defined as non-motile bacteria which conform to the definition of the family Enterobacteriaceae and have certain biochemical characteristics.

The Shigella Commission was dissolved in 1953 and its activities had since been taken over by the International Shigella Centres established throughout the world.

Enterobacteriaceae

The family Enterobacteriaceae as defined in the recent Subcommittee report (1958) is "composed of Gram negative rod-shaped bacteria which are motile with peritrichous flagella, or non-motile. They ferment glucose rapidly with or without gas production,

reduce nitrates to nitrites and grow on ordinary media."

Shigella

Wilson and Miles (1964) have defined Shigella as "Non-motile organisms conforming to the definition of the Enterobacteriaceae. Acid produced from a number of carbohydrates. Gas production restricted to members of one serotype. Usually no fermentation of lactose; when this occurs it is nearly always delayed. Adonitol and inositol never, and salicin very rarely fermented. Indole production variable.

Give a positive methyl-red and a negative Voges-Proskauer reaction and do not grow in Koser's citrate medium. Do not hydrolyse urea, deaminate phenylalanine, blacken Kligler's H_2S medium, grow in Moller's cyanide medium, utilise malonate, oxidize gluconate or liquefy gelatin. Produce glutamic acid decarboxylase.

Include a number of serotypes characterised by their somatic antigens. Pathogenic for man, giving rise to dysentery or acute gastro-enteritis. Found as a rule, in the intestinal tract of man. Type species, Shigella dysenteriae."

4. THE CLASSIFICATION OF THE SHIGELLA GROUP

The Shigella group is divided into four subgroups A, B, C and D.

Subgroup A

These are organisms which do not usually ferment mannitol. They include:

a) Shiga's bacillus described by Shiga in 1898 in Japan and by Kruse in Germany in 1900.

b) Schmitz's bacillus isolated by Schmitz in 1917 in Roumania.

c) Large-Sachs group, a number of less common types described by Andrewes (1918), Large and Sankaran (1934) and Sachs (1943).

Subgroup A is now called Shigella dysenteriae.

There are 10 serotypes differentiated by agglutination tests. Two well known serotypes are Sh. dysenteriae type 1, formerly called Sh. shigae and Sh. dysenteriae type 2, formerly called Sh. schmitzii.

Subgroup B

This group usually ferment mannitol and are interrelated serologically by the possession of common group antigens or subsidiary antigens. They are

now referred to as Shigella flexneri. Subgroup B each possess a type or main antigen by which it is differentiated from other Shigellae. In each type, there is variation in the quality and quantity of the antigens present in their group antigen complexes giving subserotypes, for example subserotypes 1a and 1b. When there is a loss of type or main antigen, the resultant variant cultures contain only group antigen factors. The variants are referred to as X and Y (Shigella Commission Report 1958). There are at present 6 serotypes, 11 subtypes and 2 variants in Subgroup B.

Subgroup C

This is a group of mannitol fermenting organisms resembling Sh. flexneri biochemically but differing from it antigenically. They are now generally referred to as Sh. boydii. There are 15 serotypes.

Subgroup D

This group contains only one serotype, Sh. sonnei, a mannitol and a late lactose fermenting organism defined by Sonne in 1915 in Denmark. A recent classification of Sh. sonnei has been made according to their production of colicines which are antibiotics that can inhibit the growth of other strains of

Shigella or other members of the Enterobacteriaceae. A method of typing Sh. sonnei using colicine production as a marker was extensively applied by Abbott and Shannon (1958) to characterise these organisms; strains which do not produce colicines are classed as untypable. There are at present 15 distinct colicine types.

The classification of the Shigella group is shown in the following table A.

TABLE A

CLASSIFICATION OF THE SHIGELLA GROUP

Subgroups	Species and serotype	Synonyms
A	Sh. dysenteriae	
Mannitol not fermented	Type 1	Sh. shigae; Shiga-Kruse bacillus
	2	Sh. Schmitzii; possibly includes some strains of B. ambiguus (Andrewes)
Types antigenically distinct	3	Q 771) Sh. arabinotarda A.
	4	Q 1167)
	5	Q 1030) Large - Sachs group;
	6	Q 454) possibly includes
	7	Q 902) some strains of B.
	8	559-52) ambiguus
	9	58)
	10	2050)
B	Sh. flexneri	Sh. paradysenteriae, B. paradysenteriae
Mannitol usually fermented Types antigenically interrelated	Type 1 Subtype 1a	V)
	Subtype 1b	VZ)
	2 Subtype 2a	W) Andrewes & Inman
	Subtype 2b	WX)
	3 Subtype 3a	Z)
	Subtype 3b	
	Subtype 3c	
	4 Subtype 4a	103 Boyd
	Subtype 4b	103Z Rewell and Bridges
	5* Subtype 5a	P119 Boyd
	Subtype 5b	
	6	Boyd 88, Newcastle and Manchester biochemical subtypes
	X variant	X)
	Y variant	Y) Andrewes and Inman

* In 1967 the International Scheme of Classification of the genus Shigella accepted that a division of Sh. flexneri serotype 5 be made into two subserotypes 5a and 5b.

Subgroups	Species and serotype	Synonyms
C	Sh. boydii	Sh. paradysenteriae
Mannitol usually fermented Types antigenically distinct	Type 1	170)
	2	P 288)
	3	D 1) Boyd
	4	P 274)
	5	P 143)
	6	D 19)
	7	Lavington 1; Sh. etouse
	8	112
	9	1296/7
	10	430
	11	34
	12	123
	13	425
	14	2770 - 51
	15	703
D Mannitol usually fermented	Sh. sonnei	Duval's bacillus; B. ceylanensis A; Kruse's B. pseudodysenteriae. Type E.

22

CHAPTER II

THE EPIDEMIOLOGY OF BACILLARY DYSENTERY IN THE UNITED KINGDOM WITH PARTICULAR REFERENCE TO THE EPIDEMIOLOGY OF FLEXNER DYSENTERY

INTRODUCTION

INCIDENCE

AGE AND SEX DISTRIBUTION

SEASONAL VARIATIONS

THE VEHICLES OF INFECTION

- (a) Flies
- (b) Water
- (c) Food

THE MODE OF SPREAD

THE ROLE OF CARRIERS

THE SUSCEPTIBILITY OF THE HOST

IMMUNITY

PROPHYLAXIS

- (a) General
- (b) Specific

SUMMARY

INTRODUCTION

In the United Kingdom, the incidence of sonne dysentery outnumbers by far that of flexner and any other type of bacillary dysentery. In consequence, there is comparatively little reference in the literature to the epidemiology of flexner dysentery whereas there are many well documented studies of sonne dysentery. Christie (1968) has in fact stated that the epidemiology of bacillary dysentery in Britain is virtually that of sonne dysentery. These two deficiencies have to be recognised in attempting to elucidate the epidemiology of flexner dysentery.

Although an attempt is made in this chapter to discuss aetiological factors specifically concerned in the epidemiology of flexner dysentery, some of these factors have had to be considered in relation to bacillary dysentery since specific identification of their role in flexner dysentery has not yet been fully determined. It is hoped however that the findings, described later in this thesis, of the retrospective study and of the prospective survey in which cases of sonne dysentery were used as controls, will help to identify aetiological factors in the epidemiology of flexner dysentery.

INCIDENCE

Bacillary dysentery is world wide in distribution with varying incidence rates in different countries according to environmental and socio-economic conditions. It is commoner in the tropics than in temperate countries largely due to low standards of sanitation and personal hygiene (Wilson and Myles 1964).

The incidence of bacillary dysentery in various countries has been reported by many observers including Bojlen in Denmark (1934), Hardy et al. (1940), and Eichner et al. (1968) in the United States, Snadjer in Yugoslavia (1954), Boyd in India (1936) and Hart in Nigeria (1954). The real incidence of the disease however is difficult to assess since in most countries only the severer cases are notified and undernotification is thus common. Ordway (1960) commented that there is incompleteness of national morbidity statistics especially from the developing countries.

In the developed countries, increasing attention has been paid to bacillary dysentery in its endemic form. In the United Kingdom, Glover (1947, 1949) has reported on endemic dysentery in England and Wales from 1919 to 1946 and in Scotland, Sutherland (1943, 1945), Gillies (1956), Bloch (1938), Carter and Young

(1952), have discussed various aspects of endemic dysentery.

AGE, SEX AND SEASONAL VARIATIONS

The detailed discussion of age, sex and seasonal variations is considered in a later chapter, but in this chapter some brief general observations are now made.

AGE AND SEX DISTRIBUTION

Although all ages are susceptible to flexner and sonne dysentery, both diseases are most common among children under five years. Male children are more often affected than females, but in adults, the sex incidence is reversed.

SEASONAL VARIATIONS

Bacillary dysentery may occur at any period of the year, the seasonal incidence varying in different countries. Strong, who described seasonal variation in some European countries in 1942, remarked that "even in temperate climates the disease is apt to occur during the warmer months of the year" and in

support of this view was the earlier observation of Bojlen (1934) who found a summer peak in Denmark.

It is interesting to note that the present seasonal peak in some countries is now different from that of fifty years ago. This has happened in the United Kingdom where in recent years the highest incidence has been in winter and not in summer months.

THE VEHICLES OF INFECTION

The spread of bacillary dysentery can take place directly from person to person or indirectly through the agency of flies or by contamination of water, milk and food. The role of each of these vehicles is now considered.

(a) Flies

The house fly (Musca domestica) has been incriminated as an indirect means of the spread of dysentery particularly in the tropics where epidemics have been associated with increase in the fly population. Kuhns and Anderson (1944) described an extensive fly-borne outbreak in which Shigella flexneri type 6 was isolated from 351 out of 383 bacteriologically positive patients

and from 9 separate batches of 15 flies. This epidemic, which was gradual in onset and widespread in distribution, reached its peak within two weeks and declined simultaneously with the disappearnce of the flies. A similar observation was noted during the British Salonika Expeditionary Campaign in 1918 when the maximum incidence of bacillary dysentery occurred when flies were most numerous.

It is probable that flies act mainly by carrying infective material mechanically on their feet, antennae and probosces and thus transmission can take place if they pass from infected faeces to food. In the United Kingdom, flies are virtually absent during the winter months when the maximum incidence of dysentery occurs and it is thus doubtful whether they play more than a relatively minor part in the transmission of the disease.

(b) Water

Although water-borne bacillary dysentery is rare, outbreaks of flexner and sonne dysentery due to contaminated water supply or faulty water systems have been reported. According to Manson-Bahr, an outbreak of water-borne flexner dysentery occurred in the Ogmore district in

Wales in 1921 which caused 12 deaths among the 1,100 persons affected. Buchanan (1918), Green and Macleod (1943) and Ross and Gillespie (1952) have each described outbreaks of water-borne sonne dysentery in the United Kingdom.

(c) Food

Infected food can cause epidemics of bacillary dysentery. Milk and ice-cream are probably the commonest articles of food responsible and several outbreaks due to these vehicles have been recorded.

An outbreak of milk-borne flexner dysentery which occurred in Aberdeen in 1919 is of particular epidemiological importance. Kinloch (1923) has described this epidemic which was explosive in nature and occurred from March to May 1919 affecting over 1,000 people and causing 72 deaths. Those affected drank infected milk from a dairy where the source of infection was probably the farmer's sister-in-law who had in the preceding two months been nursing dysentery patients in Salonika. Scott in his book 'Some notable epidemics' states that the investigation of this outbreak provided for

the first time bacteriological proof of the identification of diarrhoeal epidemics due to milk-borne infection, as prior to this similar epidemics which had occurred were not investigated bacteriologically. This outbreak was also responsible for the then Scottish Board of Health making bacillary dysentery compulsorily notifiable.

Milk-borne epidemics due to sonne dysentery have been reported from various places in the United Kingdom. These include an outbreak in Fifeshire affecting 150 persons (Fyfe 1927), one described by Trimble and Brothwood (1938) in Lancashire affecting 21 persons, and another in Bedford affecting 96 persons (Bowes 1938). In 1942, Faulds reported an outbreak of milk-borne dysentery in Cumberland affecting 43 persons and a further outbreak in 1943 affecting 124 persons. Rae and Smith (1945) described milk-borne sonne dysentery in Aberdeen which was caused by pasteurised milk from the Milk Marketing Board becoming contaminated in the dairy during bottling.

Despite these incidents, contaminated food on the whole does not appear to play a prominent

part in the spread of flexner or sonne dysentery in this country. Epidemics however tend to result from faulty food hygiene or preparation and although these outbreaks are rare, they nevertheless attract attention because of the resultant publicity and the desire to prevent similar recurrences.

THE MODE OF SPREAD

Detailed observations have been carried out on the mode of spread of sonne dysentery in this country (Hutchison 1956). Such studies have not been undertaken for flexner dysentery and most observers appear to assume that the transmission of flexner dysentery takes place in the same way as that of sonne dysentery but possibly with slight modifications.

Although bacillary dysentery may be caused by the ingestion of contaminated food or polluted water, infection in this country is usually contracted from ambulant cases in the early stages of the disease from convalescent patients or from carriers. The mechanism of this propagation may be summed up in the expression "anal oral spread" since the organisms of bacillary dysentery are excreted from the bowel

of one individual and ingested orally by another. Opportunities for a person to be infected in this way are greatly facilitated by close contact and poor personal hygiene.

It has been mentioned earlier that in the developing countries with poor environmental sanitation and lack of protection against flies, contaminated food or water supplies play a great part in causing widespread outbreaks of the disease. However as community sanitary measures improve the role of the hand to mouth contact becomes relatively more important.

In England, Hutchison (1956), in her survey of children in day and residential nurseries, demonstrated that low temperature, high humidity and diminished lighting favoured the survival of Shigella sonnei outside the human body. These three conditions were present in both domestic and institutional water closets during the winter months, December, January and February, in Southampton. She found that contamination of the water closet seat occurred readily particularly in the early stage of the disease when heavily infected fluid stools were passed. A considerable percentage of the children handled the toilet seat and thereafter touched their mouths or faces or sucked their fingers before washing

their hands. She also showed that five different kinds of toilet papers were ineffective in preventing contamination of the fingers from touching faeces.

The probable sequence of events in the spread of sonne dysentery can thus be summarised. A child with diarrhoea excreting Shigella sonnei uses a communal water closet and the seat is contaminated directly by the child or indirectly by flushing. In cleaning the peri-anal region, the fingers of the child or of the attendant may become contaminated and subsequently the attendant may pass infection to other children or the child himself may contaminate communal toys. The organisms left on the toilet seat can be taken on to the hands of any other child using the toilet soon afterwards. Thus transfer of infection occurs easily and rapidly especially during the period before and after meals when the children use the toilets.

If the seat is heavily contaminated, or if the temperature is low, the relative humidity high and lighting subdued, the organisms will remain alive for some days giving any child who uses the seat a good chance to infect himself. Each additional child's diarrhoea adds to the number of seat contaminations. This view of the spread of dysentery among schoolchildren

is supported by the observation that during holiday periods, when schools and day nurseries are closed and communal use of toilets is infrequent, the transmission and hence the incidence of dysentery is less (Bradley and Richmond 1956).

Christie (1968) has offered the following explanation for difference in the modes of spread of flexner and sonne dysentery whilst pointing out that although the explanation appears to fit the known facts, there is as yet no proof for it. He states "It may be that Shigella flexneri can cause illness only if the infecting dose is high, and it has died out in an environment where it finds it difficult to reach food or milk and multiply in it, whereas Shigella sonnei may be able to infect with the small dose which may pass from hand to hand and not require to multiply before ingestion. This would enable it to survive where sanitation was efficient but personal hygiene less than perfect, as is the case among children in modern homes and modern infant schools."

THE ROLE OF THE CARRIER

Carriers of bacillary dysentery have been classified in the past as healthy, convalescent, relapsing and chronic. It is doubtful whether such a rigid division should now be applied as some authors including Paul (1952) even deny the existence of chronic carriers.

Manson-Bahr claims that the healthy carrier, i.e. a person who excretes dysentery bacilli in a normal motion without having suffered from an acute attack of the disease, is rare. The convalescent carrier, i.e. a person who after an attack of bacillary dysentery continues to pass viable bacilli in the faeces usually with blood and mucus, constitutes the majority of carriers. The infrequency of finding true carriers and especially persistent flexner carriers led Macalister (1910) to conclude that the healthy carrier in dysentery is very rare and is negligible from an epidemiological standpoint but that the convalescent carrier is the potential danger in the spread of the disease.

In this country, the attention of earlier workers in this field was directed to finding the incidence rates of carriers among British troops during the First World War and especially among soldiers who had

been in areas endemic for bacillary dysentery. Arkwright et al. (1916) reported a carrier rate of 40 per 1,000 among convalescent service-men and Barratt (1916) found a carrier rate of 60 per 1,000 among those returning from areas endemic for bacillary dysentery. In the case of carriers of flexner dysentery, Fletcher (1917, 1918) found a rate of 22.5 per 1,000 compared with 1.2 per 1,000 of other bacillary carriers, and Kennedy and Rosewarne (1916) a bacillary carrier rate of 1.2 per 1,000 of whom 50% were flexner carriers. Although the development of a persistent carrier state is infrequent, flexner carriers may excrete the organisms for up to a year or more. Perry (1925) demonstrated that only 4% of the chronic carriers of Shigella dysenteriae were positive after one year whereas out of 271 cases of chronic carriers of Shigella flexneri, 7% were still positive at the end of one year.

In more recent years, attention in the United Kingdom has been paid to the incidence rate of healthy carriers in the general population. In 1959, a study of children under the age of 5 years reported in the Monthly Bulletin of the Ministry of Health and Public Health Laboratory Services revealed that the

overall carrier rate for bacillary dysentery was 4.2 per 1,000 but that the rates varied considerably in different parts of the country. A similar result was reported in the same journal in 1965 following investigation of a random sample of normal children. 25,249 faeces specimens were examined for Shigellae and the carrier rate found was 3.3 per 1,000. No other species of Shigella was isolated apart from Shigella sonnei. The isolation rate did not differ significantly between males and females and no statistically significant variations were present in any of the yearly age groups up to 5 years.

Since each carrier can possibly be the starting point of an epidemic, the age group under 5 years in which a high carrier rate is found therefore constitutes an important reservoir of infection.

THE SUSCEPTIBILITY OF THE HOST

The susceptibility of an individual to develop clinical features of bacillary dysentery depends to some extent on that person's resistance. Manson-Bahr (1960) and Taylor (1960) suggested that patients whose resistance was weakened by intercurrent infection or debilitating disease readily develop clinical

dysentery. Taylor found that the case-to-carrier rate of bacillary dysentery was high among children but low in adults and she thus considered that as age increases the host becomes more resistant.

She stressed however that susceptibility of the host in relation to bacillary dysentery is difficult to assess since it is impossible to measure the degree of resistance offered or the diminished resistance produced by an intercurrent infection or even to determine the dose of the infecting agent absorbed. Nevertheless she concluded that age and debilitating conditions are important factors in the production of the clinical features of the disease.

IMMUNITY

Top (1964) states that "protection in bacillary dysentery is not well understood. One attack of the infection may result in protection against the particular strain responsible for the attack, but recurrences are not uncommon and there does not appear to be much cross protection between strains." Antibodies can usually be demonstrated in the blood after an infection but their presence is irregular and in the early stage of the disease, they may be absent. Hudson (1922), in

discussing immunity to flexner dysentery, pointed out that the test for antibodies cannot be taken as a reliable evidence of the continuation or of cessation of infection whilst Hardy et al. (1948) found no relationship between the presence or absence of antibodies and the occurrence of relapses. Manson-Bahr (1943) states that there appears to be no natural immunity to bacillary dysentery and any attempts to actively immunize man by prophylactic vaccination have not yet been successful.

Recent developments since 1943 in the field of specific prophylaxis are now discussed.

PROPHYLAXIS

The prophylaxis of bacillary dysentery may be considered as general or specific.

General prophylaxis

Personal prophylaxis consists of careful attention to personal hygiene which involves cleanliness and care of the hands. Frequent thorough hand washing should be a health habit. The contamination of food, milk or water supplies particularly by food handlers should be avoided. Every effort should be made to

protect the healthy population against carriers. The convalescent carrier who may still be having occasional diarrhoea or excreting the bacilli intermittently is a danger especially among children.

Specific prophylaxis

Attempts have been made in many countries to find out if there is any safe and effective method of protecting an individual against bacillary dysentery. Ordway (1960) after an extensive review of the literature concluded that "there is at present no safe or effective immunological or chemoprophylactic method of protecting the individual exposed to enteropathogenic pathogens."

Further attempts in the field of specific prophylaxis have been carried out since 1960 by some workers. Notably among these are Mel, Terzin, Papo and Vuksic. Mel et al. (1965) in a large field trial administered live oral Streptomycin dependent Shigella flexneri 2a vaccines to 355 soldiers in a hyperendemic area for bacillary dysentery and 382 unvaccinated soldiers from the same unit were used as control. Their results demonstrated that vaccination prevented infections with Shigella

flexneri 2a in soldiers under field conditions in which unvaccinated controls revealed a relatively high morbidity although the same vaccine had no effect on the morbidity due to other Shigella serotypes. Thus an effective oral vaccine against Sh. flexneri 2a has been produced.

Another important epidemiological finding has resulted from their studies. They showed that clinical exacerbation of carriers of heterologous Shigella flexneri strains may be provoked by giving polyvalent vaccine. Epidemiologically this would have a far reaching effect because the clinical exacerbation of symptomless carriers by vaccination may be advantageous in that it would facilitate the detection and adequate treatment of such individuals.

SUMMARY

The epidemiology of bacillary dysentery as seen in the United Kingdom at the present time is primarily the epidemiology of sonne dysentery owing to the much greater preponderance of isolations of Shigella sonnei over all other Shigellae.

Bacillary dysentery is mainly a disease of children, with a higher incidence in boys than girls, occurring throughout the year but especially in the winter. It is associated with the lower social classes and wherever there is defective hygiene and sanitation. Transmission is by "anal oral spread" from person to person in houses, nurseries, schools and institutions. Although bacillary dysentery is occasionally transmitted in this country by contaminated food, milk or water supplies its incidence is not in direct relation to the frequency of fly infestation.

There is a high carrier rate among healthy children under 5 years and this age group constitutes a reservoir of infection especially of the convalescent type of carrier. Reinfection is common and immunity is lacking.

CHAPTER III

THE RETROSPECTIVE STUDY

INTRODUCTION

NOTIFICATION AND NOTIFICATION RATES

Seasonal variations

Municipal ward distribution

BACTERIOLOGICAL ISOLATIONS

(a) Incidence in Glasgow by season and serological types

(b) Incidence in Glasgow, Scotland and the United Kingdom

(c) Comparison of Glasgow with other cities

INTRODUCTION

As a preliminary to the main survey a retrospective study of the incidence of dysentery in Glasgow was made in relation to notifications and bacteriological isolations by serological types. The findings were studied against the background of the incidence in Scotland and where applicable in the United Kingdom as a whole.

NOTIFICATION

Dysentery became compulsorily notifiable in England and Wales on the 1st of March, 1919, with the passing of the Public Health Regulations 1919 and in Scotland on the 1st of August of the same year under the Public Health Regulations (Scotland) 1919. From that year systematic epidemiological information on dysentery has gradually accumulated. It was thought that by notification the disease would be brought under control and eventually eradicated but it is sad to relate that, fifty years after it became compulsorily notifiable in England and Wales and also in Scotland, dysentery is still a major cause of morbidity among the infectious diseases in Great Britain.

It is difficult to account for the large increase in the notifications which have taken place but undoubtedly better diagnostic procedures and facilities have contributed to this increase. Although notification provides a reasonable basis on which to judge the incidence of most notifiable diseases, certain factors should be borne in mind in assessing its value as a true index of the incidence of bacillary dysentery. These factors include:-

i) Only the more severe types of bacillary dysentery tend to be notified. Mild cases of the disease are often not reported to the family doctor and hence cannot be notified.

ii) Even if cases are seen by the family doctors, undernotification does occur due to their failure to notify the public health authorities.

iii) Not all notified cases are subsequently confirmed bacteriologically.

iv) Notification does not establish the species of the organism responsible for the infection.

It is probable that the efficiency of notification varies in different areas in the country and that the level of notification of cases improves during epidemic outbreaks.

NOTIFICATION RATES

Notification rates for the fifty years period from 1919 to 1968 for Scotland and for Glasgow are shown in the Appendix Tables 1-4. These figures, compiled from the Scottish Health Statistics and the Annual Reports of the Medical Officer of Health for Glasgow, show that the highest incidence of bacillary dysentery in Scotland and in Glasgow was in the 1954 - 1958 quinquennium. The highest annual notification rate for bacillary dysentery was in 1955 with value per 100,000 population of 240 in Scotland and 587 in Glasgow respectively.

Further analysis of the notifications in Glasgow was carried out to find any seasonal variations and the municipal ward distribution. To ascertain seasonal variations, a period of ten years, the decennium 1957 to 1966, was considered and for municipal ward distribution, a period of five years, the quinquennium 1962 to 1966, was studied.

The highest seasonal incidence of notifications of bacillary dysentery in the decennium 1957 to 1966 was in the 4th quarter of the year i.e. the inclement months of October, November and December (Appendix, Table 5). There was no support of an association between the incidence of bacillary dysentery and the warmer months of the year.

As will be observed from Table 6 of the Appendix which shows the distribution of bacillary dysentery among the 37 municipal wards in Glasgow, quinquennial notification rates for these wards varied from 0.26 to 8.75 per 1,000 population. Possible reasons for such variations are discussed later. The average quinquennial rate for the whole of Glasgow during this period was 2.45 per 1,000 population.

BACTERIOLOGICAL ISOLATIONS

The remainder of this chapter is concerned with the data of bacteriological isolations of the organisms. It has already been pointed out that it is only by bacteriological identification that the species of the organism responsible for the infection can be ascertained. The Public Health Laboratory Service, England, issues a weekly report of the isolations of Shigella in the United

Kingdom and since 1967 the Communicable Diseases Report, Scotland, issued from Ruchill Hospital, Glasgow, gives a separate and detailed account of the Scottish isolations.

(a) Incidence in Glasgow by Season and Serological types

The bacteriological isolations of Shigella in Glasgow during the quinquennium 1962 to 1966 were analysed to discover any seasonal variations (Table I) and to find out the incidence of the various serological types. The quinquennial incidence for Glasgow was further analysed in relation to that of Scotland and the United Kingdom and finally the findings in Glasgow were compared with those of other large cities.

It can be seen from Table I that the maximum incidence annually of both flexner and sonne dysentery during this quinquennium occurred chiefly in the 4th quarter of the year. As was found with notifications of these diseases, there is no support of any association between the incidence of flexner or sonne dysentery and the warmer months of the year.

TABLE I

Seasonal incidence in Glasgow of Sh. flexneri and Sh. sonnei for quinquennium 1962 - 1966 from bacteriological isolations

	1st Quarter	2nd. Quarter	3rd Quarter	4th Quarter	Total
Sh.flexneri					
1962	24	21	27	75	147
1963	78	88	83	83	332
1964	155	133	175	237	700
1965	260	175	142	178	755
1966	145	127	154	163	589
	662	544	581	736	2523
Sh.sonnei					
1962	162	192	148	230	732
1963	232	444	312	474	1462
1964	794	384	204	407	1789
1965	396	322	275	340	1333
1966	220	155	253	518	1146
	1804	1497	1192	1969	6462

Appendix Table 7 shows the different serological types of Shigella flexneri isolated in Glasgow in the same quinquennium 1962 - 1966. Out of 2,523 isolations, Shigella flexneri type 6 accounted for 1,133 (45%); next in frequency were types 3a, 859 (34%) and type X, 240 (9.5%) the other serotypes were infrequently isolated. It is worthy of note that in 1962 type 6 was the commonest serological type isolated whereas in 1966 type 3a was commonest.

(b) Incidence in Glasgow, Scotland and the United Kingdom

The main species isolated in the United Kingdom are Shigella sonnei and Shigella flexneri; the other species Shigella dysenteriae and Shigella boydii are met with infrequently. Shigella sonnei constitutes the bulk of the total isolations of the Shigella group (Table II).

TABLE II

Yearly incidence of Shigella in the United Kingdom 1962 - 1966

	Shigella sonnei	Shigella flexneri	Other Shigellae
1962	33,032	720	65
1963	34,516	1,103	28
1964	24,049	1,455	17
1965	30,747	1,500	14
1966	27,174	1,230	23

The yearly ratio of flexner to sonne isolations for the United Kingdom, Scotland and Glasgow for the same period is shown in Table III.

TABLE III

Yearly ratio of Flexner / Sonne for U.K., Scotland and Glasgow 1962 - 1966

	U.K.	Scotland	Glasgow
1962 Flexner / Sonne	720 / 33,032	183 / 1,368	147 / 732
1963 Flexner / Sonne	1,103 / 34.516	499 / 2,129	332 / 1,462
1964 Flexner / Sonne	1,455 / 24,049	782 / 3,018	700 / 1,789
1965 Flexner / Sonne	1,500 / 30,747	830 / 3,305	755 / 1,333
1966 Flexner / Sonne	1,230 / 27,174	659 / 2,225	589 / 1,146

As the figures for the United Kingdom necessarily include Scotland and those for Scotland include Glasgow, the high number of Glasgow isolations exerts a predominant influence especially on the Scottish figures. This influence is borne out in Tables IV and V where the yearly ratios of flexner to sonne isolations are expressed as percentages.

TABLE IV

Yearly ratio of Flexner / Sonne isolations expressed as a percentage for the U.K., Scotland and Glasgow

Year	U.K.	Scotland	Glasgow
1962	2.2	13.4	20.1
1963	3.2	23.4	22.7
1964	6.1	25.9	39.1
1965	4.9	25.1	56.6
1966	4.5	29.6	51.4

TABLE V

Yearly ratio of Flexner / Sonne isolations expressed as a percentage for the U.K. without Glasgow, Scotland without Glasgow and Glasgow itself

Year	U.K. - Glasgow	Scotland - Glasgow	Glasgow
1962	1.8	5.7	20.1
1963	2.3	25.0	22.7
1964	3.4	6.7	39.1
1965	2.5	3.8	56.6
1966	2.5	6.5	51.4

The percentage yearly ratios of flexner to sonne isolations can be summarised as follows:

U.K. including Scotland and Glasgow	2 to 6%
Scotland including Glasgow	13 to 29%
Glasgow	20 to 56%
U.K. not including Glasgow	1 to 3%
Scotland not including Glasgow	3 to 25%
Glasgow	20 to 56%

In other words for every 100 isolations of Shigella sonnei there are between 1 to 3 isolations of Shigella flexneri in the United Kingdom, between 3 to 25 in Scotland and between 20 to 56 isolations of Shigella flexneri in Glasgow.

Thus Glasgow has a greater proportion of Shigella flexneri than the average for the whole of the United Kingdom and the average for Scotland.

(c) Comparison of Glasgow with other Cities

In the Annual Report of the Medical Officer of Health of Glasgow for 1965 it is stated on page 310 that "it remains to be seen whether Sh. flexneri will again reassert themselves as the predominant types in Glasgow, but whether this happens or not, the fact remains that no other British city or town, with the possible exception of Liverpool, is pestered on a comparable scale with Flexner dysentery." It is sometimes asserted that Glasgow and Liverpool have a high incidence of flexner dysentery because they are major seaports. It is interesting however to find stated on page 30 of the Annual Report of the Medical Officer of

Health of Birmingham for 1964 that "it will be noted that Sh. flexneri was found almost as commonly as Sh. sonnei and that indeed in the second quarter of the year, Sh. flexneri was the commoner of the two organisms. Shigella flexneri now seems to be well established in this city."

In view of the above quotations, the annual rates of bacteriological isolations of Shigella flexneri in the two seaports, Glasgow and Liverpool, were analysed together with those of Birmingham, a city of approximately the same population as Glasgow (Table VI).

TABLE VI

Annual rates of bacteriological isolations of Shigella flexneri per 100,000 population in Glasgow, Birmingham, Liverpool and the United Kingdom for the quinquennium 1962 to 1966

	Glasgow	Birmingham	Liverpool	United Kingdom
1962	14.1	1.8	0.3	1.3
1963	32.3	8.8	1.6	2.1
1964	68.7	12.2	1.4	2.7
1965	75.4	2.9	0.4	2.8
1966	60.1	1.8	0.7	2.2
Rate in quinquennium 1962 - 1966	49.7	5.5	0.9	2.2

It can be seen from the foregoing table that

1. Glasgow and Birmingham have each a higher incidence rate of flexner dysentery than the average for the United Kingdom.

2. Contrary to expectation, Liverpool has a lower incidence rate of flexner dysentery than the average for the United Kingdom and is indeed 1/55 of the rate of Glasgow.

The yearly ratios of flexner to sonne isolations for the three cities in the quinquennium 1962 to 1966 are given in Table VII.

TABLE VII

Yearly ratios of Flexner isolations expressed as Sonne a percentage for the three cities from 1962 - 1966

	Glasgow	Birmingham	Liverpool	United Kingdom
1962	20.1	2.8	0.1	2.2
1963	22.7	33.3	0.9	3.2
1964	39.1	55.3	0.8	6.1
1965	56.6	7.3	0.4	4.9
1966	51.4	5.7	0.5	4.5
Ratio in quinquennium 1962 - 1966	39.0	14.9	0.6	4.0

In the above quinquennium, for every 100 isolations of Shigella sonnei there are 39 isolations of Shigella flexneri in Glasgow, 14 isolations in Birmingham and only 0.6 isolations in Liverpool. Thus the commonly asserted assumption that Liverpool is afflicted with flexner dysentery on a comparable scale to Glasgow cannot be upheld.

CHAPTER IV

THE PRESENT SURVEY -- MATERIAL AND METHODS

COMPILATION OF A QUESTIONNAIRE

THE POPULATION STUDIED

CASES AND CONTROLS

COMPLETION OF THE QUESTIONNAIRE

THE QUESTIONNAIRE

To study the epidemiology of flexner dysentery a questionnaire was completed for each individual included in the survey. This questionnaire, of which there is a specimen copy in the pocket of Volume II, was self-devised. In designing it, particular attention was paid to the inclusion of:

1. factors which might indicate the medico-social background of the patients

2. clinical details which could usefully contribute to the epidemiology of flexner dysentery and

3. data facilitating international comparability of results.

In completing the questionnaire all interviews in hospital and at home were personally conducted by the writer and to avoid subject and observer variations, subjective questions were kept to a minimum. A pilot study to test out the questionnaire preceded the main survey.

THE POPULATION STUDIED

All bacteriologically positive cases of flexner and of sonne dysentery admitted during the seven months period, April to November 1968, to the two infectious disease hospitals in Glasgow, Belvidere and Ruchill, were studied. Any patient admitted with clinical dysentery which was not confirmed bacteriologically was excluded from the survey. 360 patients, 132 with flexner and 228 with sonne dysentery, comprised the population studied.

CASES AND CONTROLS

It was considered desirable to have a control series so that any differences primarily due to flexner dysentery could be effectively distinguished. To avoid sampling errors in selecting a control series, all patients from whom Shigella flexneri were isolated were regarded as "Cases" and all patients with Shigella sonnei as "Controls". This differentiation of the "Cases" and the "Controls" according to the type of bacillary dysentery has been maintained throughout the thesis.

COMPLETION OF THE QUESTIONNAIRE

(a) Interviewing in Hospitals

Every patient aged 15 years and over with bacteriologically confirmed flexner or sonne dysentery admitted to hospital during the period of the survey was personally interviewed and for those under that age details were obtained from the parent or guardian visiting the child. The case-notes of each patient were studied and any relevant information particularly of previous hospitalisation due to diarrhoeal illness extracted.

It was usually possible to obtain full medico-social details of all hospital patients, apart from those children in care admitted from children's homes and institutions, whose previous home background details were often incomplete.

(b) Interviewing at home

Where it was not possible to interview any patient or the relatives before discharge from hospital, a home visit was made. Irregular discharge, accelerated discharge and failure by the parent or guardian to visit the child were the chief reasons why some

questionnaires could not be completed in hospital thus making a home visit necessary.

Every questionnaire was checked on completion and the information coded and transferred to Hollerith cards which were subsequently verified and analysed by sorter.

CHAPTER V

THE PRESENT SURVEY - RESULTS

SECTION I - DEMOGRAPHIC DATA

1. Distribution of "Cases" and "Controls"
2. Age and sex incidence
3. Nationality
4. Social class distribution
5. Social class of mothers in employment
6. Municipal ward distribution

SECTION II - HOUSING CIRCUMSTANCES

1. House description
    1. Type of house
    2. Ownership of the house
    3. Number of rooms in the house
    4. Number of children in relation to number of rooms in house
2. Sanitary facilities in the home
    1. Availability of water closet
        (a) Location and sharing of water closet
        (b) Number of children per water closet
    2. Adequacy of other toilet facilities
3. Sanitary facilities in the municipal wards
    1. Availability of water closet
        (a) Location of water closet
        (b) Number of children per water closet
    2. Adequacy of other toilet facilities
4. Home Visits

SECTION III - INCIDENCE OF DIARRHOEA AMONG CHILDREN

1. Incidence in households
2. Incidence in schools

SECTION IV - PATIENTS AND THEIR CONTACTS

1. Previous attacks of dysentery
2. Present symptoms
3. Antecedent contact
4. Description of contacts
5. Introduction of infection
6. Source of infection
7. Health educational status of the patients
8. Reasons for hospitalisation
9. Length of stay in hospital
10. Comparison of the two hospitals
11. Length of stay in relation to age of patient
12. Cost of hospitalisation

SECTION V - RESISTANCE OF SHIGELLA TO ANTIMICROBIAL DRUGS

1. Resistance to Specific Drugs

   (a) Neomycin, ampicillin, tetracycline, sulphafurazole, colomycin and nalidixic acid

   (b) Cephaloridine and kanamycin

   (c) Chloramphenicol, polymyxin B, streptomycin and paromomycin

   (d) Variations in drug resistance according to hospital

   (e) Resistance of different serological types of Sh. flexneri

   (f) Specific resistance in relation to previous hospitalisation

2. Multiple Resistance

   (a) Strains of Shigella flexneri

   (b) Strains of Shigella sonnei

   (c) In relation to previous hospitalisation and age of patient

3. Cross Resistance

THE PRESENT SURVEY - RESULTS

The detailed results of the investigations in this survey are presented in a series of tables in the Appendix and it is suggested that these tables be studied paripassu with the results given in this chapter.

SECTION I - DEMOGRAPHIC DATA

Distribution of "Cases" and "Controls"

Of the 360 patients studied, 132 (36.7%) were affected by flexner and 228 (63.3%) by sonne dysentery (Table 8). Thus in the whole survey, there were 58 patients with flexner for every 100 with sonne dysentery. There was one death - a child aged one year with sonne dysentery where post mortem examination confirmed the cause of death as pneumonia, septicaemia and dysentery.

173 of these 360 patients were admitted to Belvidere Hospital and 187 to Ruchill Hospital. 67 (38.7%) of the 173 patients in Belvidere and 65 (34.8%) of the 187 patients in Ruchill had flexner dysentery (Table 9). Throughout the thesis patients suffering from flexner dysentery have been regarded as the "Cases" and those suffering from sonne dysentery as the "Controls".

55.6% of the patients admitted to Ruchill were males as compared with 41.6% admitted to Belvidere and in the case of female patients 44.4% were admitted to Ruchill compared with 58.4% to Belvidere (Table 10). This difference of 14% in sex distribution was partly due to administrative reasons as in Glasgow adult males suffering from suspected dysentery are generally admitted to Ruchill and adult females to Belvidere.

Five out of the eleven possible serotypes and sub-serotypes of Shigella flexneri were isolated from the 132 patients with flexner dysentery viz. types 2, 2a, 3a, 6 and X. Type 3a (56.8%) was commonest, followed by type X (37.9%) and all the remaining three types accounted for only 5.3% (Table 11).

Age and Sex Incidence

Age

The age and sex distributions of the 360 patients are detailed in Tables 12 and 13.

11.9% were adults and 88.1% were children i.e. persons under 15 years of age. 87.1% of all flexner and 88.6% of all sonne patients were children. In both the "Cases" and the "Controls", the 1-4 year age group had the highest incidence of infection, accounting

for 68.1% of flexner and 63.1% of sonne infections and, in the age group under one year, the percentages were 12.9% for flexner and 17.5% for sonne. These figures emphasize that bacillary dysentery is found mainly among children.

43 of the 360 patients in the series were adults of whom 27 were married.

Sex

The incidence of both flexner and sonne dysentery in children under one year was greater in males than in females.

8 (12.1%) of the 66 male patients and 9 (13.6%) of the 66 female patients with flexner dysentery were adults. In the case of sonne dysentery, only 6 (5.5%) of the 110 male patients were adults as compared with 20 (17%) of the 118 female patients. Thus in this survey, the attack rate for sonne dysentery in adult females (17%) was over 3 times higher than for adult males (5.5%) but for flexner dysentery there was no appreciable difference between the sexes.

Nationality

The nationalities of the patients are given in Table 14. 93.1% of flexner and 83.3% of sonne patients were Scottish, 3% of flexner and 3.9% of sonne, Irish; and 2.3% of flexner and 2.2% of sonne, English. There were no Indians and Pakistanis among flexner patients but they formed 1.8% of the sonne patients. The only other nationality found among flexner patients was Italian and the other nationalities among sonne patients were Greek, Italian, German and American. No West Indians or Africans were affected by flexner or sonne dysentery.

Social Class Distribution

The Registrar-General's Social Classification of Occupations 1966 was modified as follows for use in the survey:

Social Class:	I	Professional, etc. occupations
	II	Intermediate occupations
	III	Skilled occupations
	IV	Partly skilled occupations
	V	Unskilled occupations
	VI	Unemployed i.e. not working for a period over 3 months
	VII	Retired
	VIII	Not known or unavailable

Social classes I - V are identical with the Registrar-General's classification. Social class VI indicates persons unemployed for a period of over 3 months immediately preceding the date of interview and social class VII retired persons. Social class VIII was used for those patients where information on the father's occupation was not available as for example in instances of illegitimacy or of children in residential care. Details of social class distribution are given in Table 15.

31.8% of flexner patients were in social class VI, the unemployed group; 30.3% in social class V the unskilled occupations, and 17.4% in social class III, the skilled occupations. On the other hand, 26.8% of sonne patients were in social class III, 22.4% in social class VI, and 19.3% in social class V.

Thus patients in this survey came predominantly from social classes III, V and VI. The significance of social class distribution in relation to both flexner and sonne dysentery is discussed in the next chapter.

As regards occupational state, only 12 patients in the whole survey were in employment; 6 of these had flexner and 6 sonne dysentery and none were food handlers.

Social class of mothers in employment

Table 16 shows the social class distribution of mothers who were in full or part-time employment. Among 114 flexner patients, only 2 patients had mothers employed full time and 6 patients mothers employed part-time whereas among 185 sonne patients, 8 had mothers employed full time and 18 mothers employed part-time. Employed mothers were 7% fewer among flexner than among sonne patients.

i) Mothers employed full time

The two flexner patients whose mothers were in full time employment were both in social class VI. None of the 8 sonne patients whose mothers were in full time employment was in social class VI.

ii) Mothers employed part-time

Of the 6 flexner patients whose mothers were in part-time employment, 4 were in social class V and one in each of social classes III and IV whereas of the 18 sonne patients whose mothers were in part-time employment, 3 were in social class V, 8 in social class III and 2 in social class IV.

iii) Mothers not employed

Of the 106 flexner patients whose mothers were not gainfully employed, 38 (35.9%) were in social class VI and of the 157 sonne patients, 41 (26.1%) were in social class VI.

The incidence in the survey where both parents were unemployed was 9.8% higher among flexner than sonne patients.

Municipal Ward Distribution

336 (93.3%) of the 360 patients, 129 flexner and 207 sonne patients, lived in Glasgow and only 3 flexner and 21 sonne patients came from outside the city. One flexner and 25 sonne patients came from residential institutions - children's homes and nurseries-and all but two of these patients were from Glasgow.

Tables 17 and 18 show the distribution of the patients in the 37 municipal wards of Glasgow. The number of patients from these wards varied between 0 to 17 for flexner and 0 to 29 for sonne patients and the mean number of flexner and sonne patients for the wards were 3.4 and 4.9 respectively. In 14 of the 37 municipal wards, the number of flexner patients was

greater than the mean number for all the wards, 15 wards had lower values and 8 wards had no patients with flexner dysentery. Among sonne patients, the number was greater than the mean for all wards in 9 of the 37 wards, 25 wards had lower values than the mean and 3 wards were not affected. This distribution appears to indicate that flexner dysentery is possibly localised in some wards but that sonne dysentery is widely scattered throughout the city.

Four of the wards with a high incidence of flexner dysentery also had a high incidence of sonne dysentery and correspondingly, four other wards with a low incidence of flexner dysentery had a relatively low incidence of sonne dysentery.

SECTION II - HOUSING CIRCUMSTANCES

House Description

Type of house

The type of house occupied by the patients was classified into one of seven groups (Table 19). 129 (97.6%) of the 132 flexner patients and 180 (78.9%) of the 228 sonne patients occupied tenements and of these tenement dwellers, 70 (53%) flexner and 75 (32.9%) sonne patients stayed in houses with an outside water closet. This value of 53% among flexner patients is significantly different from that of 32.9% among sonne patients ($P < 0.001$).

One flexner and 25 sonne patients lived in institutions. The high number of such patients with sonne dysentery was mainly due to an outbreak of the disease in a children's home.

Only 2 flexner and 23 sonne patients lived in the four other types of houses listed in Table 19.

Ownership of the house - (Table 20)

40 (30.3%) of the 132 patients with flexner dysentery lived in local authority houses belonging to Glasgow Corporation, 57 (43.2%) in houses owned

by private landlords and 34 (25.7%) had self-owned houses. 109 (47.8%) of the 228 sonne patients lived in houses owned by the local authority, 69 (30.2%) stayed in houses owned by private landlords, and 46 (20.2%) had purchased their own houses. Thus the commonest type of house ownership was private owned in the case of flexner patients and local authority controlled in the case of sonne patients.

Number of rooms in the house - (Table 21)

Although the 360 patients lived in houses varying in size from one to nine apartments, 167 (46.4%) stayed in houses of 1 or 2 apartments - one apartment or single end, 2 apartments or room and kitchen houses.

77 (58.3%) of the 132 flexner and 90 (39.5%) of the 228 sonne patients occupied such dwellings. These findings reveal the high incidence of small size houses occupied especially by flexner patients.

Number of children in relation to number of rooms in house - (Table 22)

13 flexner patients lived in one apartment houses and of these households, there were 4 families with 2 children and 3 with 3 children. Of the 17 sonne

patients residing in one apartment houses, 3 households had 2 children and 5 had 3 children apart from the parents. A similar high children's occupancy was found in the households of the 64 flexner and 73 sonne patients who came from 2 apartment houses.

Sanitary facilities in the home

Two aspects of sanitary facilities were investigated in detail - availability of water closet and adequacy of other toilet facilities. Availability of water closet included location in the house, whether shared by families, and the number of persons particularly children using each one. Adequacy of other toilet facilities included the presence of a wash hand basin in the toilet, a hot water system heated by electricity or gas geyser, and a fixed bath or shower in the house.

Availability of water closet

(a) Location and sharing of water closets - (Tables 23 and 24)

Of the 132 flexner patients, 70 (53%) lived in houses with outside water closets and of these 70, 51 stayed in houses where the water closets were situated on the stairs, 18 where they were

in the backcourt and one where it was in the lobby. 75 (32.9%) of the 228 sonne patients lived in houses with outside water closets and of these 75, 41 stayed in houses with water closets on the stairs and 34 where they were in the backcourt.

All 70 of the 132 flexner patients shared their outside water closets with 2, 3, 4 or even 5 families but only 78 of the 228 sonne patients shared water closets. Thus the majority of flexner patients (53%) stayed in houses with outside water closets either on the stairs or in the backcourt and shared between 2 to 5 families whereas the majority of sonne patients (56.6%) lived in houses with their own inside water closets.

(b) Number of children using water closets - (Table 25)

In the families of the 132 flexner patients 56 (42.4%) had a ratio of 5 children and over per w.c. and of these 56, 12 had 6 and 23 had 7 children and over per w.c. The findings for sonne patients confirm to a lesser extent the high percentage of children per water closet.

85 (36.7%) stayed in houses with 5 children and over per w.c. and of these 85, there were 25 with 6 and 45 with 7 children and over per w.c.

Adequacy of other toilet facilities

Table 26 indicates the adequacy or inadequacy of other toilet facilities available in the houses of the patients. For ease of comparison, patients with flexner dysentery are considered as one group, "the Cases" in contrast to patients with sonne dysentery, as the other group, "the Controls".

(a) Houses with inside water closet

60.7% of the "Cases" stayed in houses which had a wash hand basin in the same room as the water closet as compared with 77.3% of the "Controls"; 68.9% of the "Cases" had a hot water system compared with 84.4% of the "Controls" and 60.7% of the "Cases" had a fixed bath compared with 79.7% of "Controls". Thus in the houses of the "Controls" as compared with the "Cases" there were -

1. 16.6% more patients with a wash hand basin in the same room as the water closet

2. 15.5% more with a hot water system

and 3. 19% more with a fixed bath or shower.

These findings indicate the poor standard of housing conditions particularly in toilet facilities encountered in this survey among the patients who had flexner dysentery.

(b) Houses with outside water closet

All 70 flexner and all 75 sonne patients lived in houses which were without a wash hand basin in the same room as the water closet and which had no fixed bath or shower. There was only a difference of 0.4% in favour of the control group as regards houses having a hot water system.

Patients residing in institutions were excluded since full details of their housing and sanitary circumstances were not available.

Sanitary facilities in the municipal wards

Availability of water closet

(a) Location of water closet - (Tables 27 and 28)

Over 70% of the patients from each of the four wards with a high incidence of flexner dysentery and over 60% of the patients from each of the four wards with a high incidence of sonne dysentery lived in houses with outside water closets. Two municipal wards with a high incidence of flexner and sonne dysentery were the exceptions. As these wards largely comprised new housing properties, all the patients stayed in houses with inside water closet.

All patients from all but two of the eight wards with a low incidence of flexner dysentery lived in houses with inside water closets and all patients from all but one of the six municipal wards with a low incidence of sonne dysentery lived in houses with an inside water closet.

Thus a high incidence of flexner and sonne dysentery was found in those wards where the patients lived in houses with outside water closets and correspondingly a low incidence was

predominant in wards where the patients lived in houses with inside water closets.

(b) Number of children using water closet

Tables 29 and 30 which detail the number of children per water closet in relation to municipal wards, show that a ratio of over 5 children per water closet was frequently found in those wards with a high incidence of flexner and of sonne dysentery whereas municipal wards with a low incidence of flexner or sonne dysentery had a ratio of only 1 or 2 children per water closet.

Adequacy of other toilet facilities - (Tables 31 and 32)

Over 80% of the patients from each of the six wards with a high incidence of flexner dysentery lived in houses without a fixed bath or shower and with no wash hand basin in the same room as the water closet. The majority of the houses had outside water closets and no hot water system. Only in one of these six municipal wards did the patients have adequate toilet facilities.

Inadequate toilet facilities - no fixed baths, no wash hand basin and no hot water system - were

common in the houses of the patients from the six municipal wards with a high incidence of sonne dysentery. Only in the houses of the patients from the two wards with new housing schemes were adequate toilet facilities available.

Adequate toilet facilities - fixed baths, hot water system, wash hand basin and inside water closets - were found in the houses of patients in only two of the eight wards with a low incidence of flexner dysentery, and in only two of the six wards with a low incidence of sonne dysentery did the patients have adequate toilet facilities.

Thus in municipal wards with a high incidence of flexner or sonne dysentery, the majority of the patients' houses lacked adequate toilet facilities.

Home Visits

The homes of 40 (11.1%) of the 360 patients in this survey were visited. 18 of these 40 patients suffered from flexner and 22 from sonne dysentery; 14 had been admitted to Belvidere and 26 to Ruchill Hospital. Their homes were widely scattered throughout the city covering 22 of the 37 municipal wards.

An assessment of the housing circumstances with particular reference to the existing sanitary conditions was made at each visit. Visits were made to 38 houses, 17 with outside and 21 with inside water closets. Of the 17 tenements with outside water closets, 10 water closets were on the stairs, 6 in the backcourt and 1 in the lobby. The two remaining visits were paid to a terraced house and a converted church building.

In the 40 households, 15 families shared water closets, 20 families had 5 children or more per water closet, 19 had a wash hand basin in the toilet, 23 had a hot water system and 20 a fixed bath.

A subjective assessment of the standard of cleanliness in the house was personally made in each instance and of these 40 households, only 9 were classified as clean, 11 were fair and 20 dirty. Many of the houses classified as dirty were also in need of repair and a few had actually been condemned for demolition. Although all these houses had water closets, many were in disuse through disrepair. Other signs of squalor were only too often present.

SECTION III - INCIDENCE OF DIARRHOEA AMONG CHILDREN

Although Ordway's* definition of diarrhoea is used in the report of the World Health Organisation Expert Committee on Enteric Infections 1964, in this survey the shorter working definitions of diarrhoea given by the W.H.O. Scientific Group and cited by Cvjetanovic** 1963 have been employed viz:

1. Children less than 3 years of age. Three or more soft or liquid stools within 12 hours or a single soft or liquid stool containing blood, pus, or mucus.

2. Persons 3 years of age and over. Two or more soft or liquid stools within 12 hours or a single soft or liquid stool containing blood, pus, or mucus.

Ordway,* N.K., 1960, Bull. Wld. Hlth. Org., 23, 73. Ordway's definition - "diarrhoea is a disturbance of intestinal motility and absorption which, once and by whatever means initiated, may become self-perpetuating as a disease through the production of dehydration and profound cellular disturbances, which in turn favour the continuing passage of liquid stools."

Cvjetanovic,** B., 1963. An epidemiological approach to the study of diarrhoeal diseases. Epidemiology. Pemberton. Oxford University Press. London.

Incidence in households - (Table 33)

The occurrence of diarrhoea, a cardinal sign of dysentery, among other children in those households where a child had suffered from dysentery in the immediate three months prior to the patient's attack was noted. The number who had had diarrhoea in each age group was contrasted with the total number of children exposed or at risk in the same age group. It was fully appreciated that these findings are largely dependent on accurate histories being given by the parents.

According to the parents' statements, 286 (73.1%) of the 391 children at risk of infection in the households of flexner patients had diarrhoea as had 444 (64.3%) of 690 children at risk in households of sonne patients. In the five age groups tabulated, the percentages with diarrhoea among those at risk varied in flexner households from 68.1 to 85.7 and in sonne households from 41.1 to 75.7.

Thus diarrhoea was very widespread among other children in households where there was already a child with flexner or sonne dysentery.

Incidence in schools

It was thought desirable to ascertain the incidence of diarrhoea among other children in the schools of the patients suffering from dysentery and if there was any connexion between home and school in the spread of the disease.

Only one of 35 nursery and school children patients with flexner dysentery definitely stated that diarrhoea was present amongst other children. In this instance, the diarrhoea at the school occurred previous to the patient's attack. 12 patients knew of no diarrhoea and 22 were uncertain.

9 out of 84 nursery and school children patients suffering from sonne dysentery stated that diarrhoea had occurred among other children in their school. All 9 patients were from a school where an outbreak had occurred; 7 stated that diarrhoea in the school started before and 2 immediately after they had their attack of dysentery. 12 other patients knew of no diarrhoea and 63 were uncertain.

SECTION IV - PATIENTS AND THEIR CONTACTS

Previous attacks of dysentery

All the 360 patients were asked if they had suffered from a previous attack of dysentery and in all instances where a history of previous hospitalisation due to dysentery was given, the hospital case notes were checked to confirm this. Of the 13 flexner and 26 sonne patients with previous attacks of bacillary dysentery, 11 flexner and 20 sonne patients had a previous hospital admission (Table 34).

Of the 11 flexner patients, 9 had been admitted once previously, one patient admitted on 3 occasions and another, a child aged 2 years, had been admitted to hospital 7 times due to dysentery of different serological types. Of the 20 sonne patients, 16 had been hospitalised once and 4 patients twice. Thus previous hospital admission due to dysentery was not uncommon among both flexner and sonne patients.

Present Symptoms

It can be observed from Table 35, which gives the approximate duration of symptoms of the patients before admission to hospital, that only 7 (5.3%) of

the 132 flexner patients but 52 (22.8%) of the 228 sonne patients had no symptoms on admission. The high percentage of symptomless patients found among those with sonne dysentery illustrates the mildness of the illness contracted.

Antecedent Contact

Table 36 indicates the distribution of patients who had antecedent contact with persons suffering from diarrhoea. 62 (46.9%) of the 132 flexner patients and 90 (39.5%) of the 228 sonne patients had been in contact in the fortnight prior to their own attack with someone suffering from diarrhoea. Thus the group of patients with flexner dysentery were more in contact with persons suffering from diarrhoea than the group with sonne dysentery.

Description of Contacts - (Table 37)

Of the 62 flexner patients who had antecedent contact with persons suffering from diarrhoea, 33 (53.2%) had contacts who lived in the same house and 29 (46.8%) had contacts who lived outwith their house but in Glasgow; on the other hand 43 (47.8%) of the 90 sonne patients had contacts living in the

same house and 47 (52.2%) had contacts who lived outwith their house but in Glasgow. Thus there were 5.4% more contacts living in the same house in the case of flexner than of sonne patients.

Preschool children constituted the majority of contacts living in the same house as the patient for both flexner (17 out of 33) and sonne (32 out of 43) patients. School children in 15 out of 29 flexner and 22 out of 47 sonne patients formed the major group of contacts living outwith the patient's home but in Glasgow.

No contacts lived outside Glasgow.

Introduction of infection

It can be observed from Table 38, which details patients absent from Glasgow in the week preceding infection, that of the 132 flexner patients, only one had been elsewhere in Scotland; 6 of the 228 sonne patients had been outside Glasgow, 4 elsewhere in Scotland and 2 in England. None of the patients had been abroad immediately prior to infection.

Source of infection

26 (19.7%) of the 132 flexner patients and 30 (13.2%) of the 228 sonne patients considered they knew the source of their infection (Table 39). The sources stated included close association with contacts, suspected articles of food and poor housing conditions.

Only 6 flexner and 8 sonne patients considered that a particular foodstuff consumed during the week before the infection was responsible for their attack (Table 40).

Health educational status on the prevention of dysentery

Under health educational status is included the opinion of each patient on the prevention of dysentery and such opinions are graded as shown in Table 41. Out of the 132 flexner patients, 74 (56%) considered washing of hands after using the water closet the most important factor in preventing a further spread of dysentery in their households. 41 (31%) considered living in a house with inside water closet, bathroom and wash hand basin as the most important and 14 (10.6%) had no idea.

Of the 228 sonne patients, 123 (53.9%) considered washing the hands most important, 61 (26.8%) having a house with suitable toilet facilities and 22 (9.7%) had no idea. Thus over 50% of both groups were aware of the importance of personal hygiene and hand cleanliness and approximately 10% of both flexner and sonne patients were ignorant of any general prophylactic measures for dysentery.

Tables 42 and 43 show the health educational status of the patients on the prevention of dysentery in relation to social class, adequacy of toilet facilities and previous attacks of the disease. Although no definite pattern of the health educational status of patients emerges in social classes III to VIII, 13 out of 16 flexner and sonne patients in social classes I and II considered washing of hands after using the water closet the most important prophylactic measure.

Of the 70 flexner patients who lived in houses with outside water closets, 28 considered having a house with adequate toilet facilities the most important factor. 41 of the 75 sonne patients residing in houses with outside water closets considered having adequate toilet facilities as most important.

Of the 13 flexner patients who had previous attacks of dysentery, 11 (84.6%) considered hand cleanliness the most important prophylactic measure but of the 26 sonne patients who had previous attacks of dysentery, only 11 (42.3%) were of a similar opinion whilst 7 (26.9%) were completely ignorant of any prophylactic measure. This indicates that even among those who had previous attacks of dysentery there is still scope for further health education.

Reasons for hospitalisation

The reasons for admission to the two infectious disease hospitals Belvidere and Ruchill were classified into two main groups - medical and social (Table 44). The medical reasons for admission were severity of illness and the incidental isolation of Shigella from patients with other illnesses in non-infectious disease hospitals. In this survey, such incidental isolations came from antenatal patients in a maternity hospital and from children with osteomyelitis, etc. who developed dysentery in a surgical unit.

The social reasons for admission included unsatisfactory housing conditions, danger of infection to others in the household, presence of food handlers

in the households, parents in full time employment, and patients transferred from residential institutions.

78 (59.1%) of the 132 flexner patients were admitted for medical reasons and of these 78, 58 were severely ill and 20 were patients from whom incidental isolation of Shigella had been made. Of the 228 sonne patients, 124 (54.4%) were admitted for medical reasons and of these 124, 76 were severely ill and 48 were patients with an incidental isolation of Shigella.

For the purpose of this survey, severely ill patients were defined as those patients with 1) any complications e.g. convulsions, dehydration, etc. or 2) persistent vomiting and/or diarrhoea, accompanied with blood, pus or mucus, which had not responded to treatment given by the general practitioner.

Severely ill patients were commoner by 10.6% among flexner than sonne patients.

Out of the 360 patients in the survey, 202 (56.1%) were admitted for medical reasons and 158 (43.9%) for social reasons. Of the 158 patients 54 were flexner and 104 sonne, thus indicating the high number particularly of sonne patients admitted to hospital for social reasons.

Length of stay in hospital - (Table 45)

The length of stay in hospital for both flexner and sonne patients ranged from 1 to 7 weeks except in the case of 2 patients, one with flexner and one with sonne dysentery who were each in for over 14 weeks. Of the 132 flexner patients, 8 were in hospital for less than a week and of 228 sonne patients, 10 were in hospital for less than a week. Irregular discharge for various reasons largely accounted for those in hospital for less than a week. The mean number of days in hospital of 20.9 per flexner patient was slightly higher than that of 19.4 per sonne patient (Table 47).

Comparison of the two hospitals - (Tables 46 and 47)

Of the 67 patients admitted to Belvidere hospital with flexner dysentery, 11 (16.4%) were in for less than 14 days whereas 21 (32.3%) of the 65 patients in Ruchill Hospital were in for less than 14 days. Among the 106 sonne patients admitted to Belvidere 10 (9.4%) were discharged within a fortnight as compared with 49 (40.2%) of the 122 sonne patients admitted to Ruchill. The mean number of 22.5 days per flexner patient in Belvidere was greater than that of 19.3 in Ruchill and

likewise the mean number of days per sonne patient in Belvidere, 22.0, was greater than the 17.1 days in Ruchill. The reasons for these differences are mainly due to the different criteria of cure required before discharge from each hospital and are discussed further in the next chapter.

Length of stay in relation to age of patient - (Tables 48 and 49)

Out of the 90 flexner patients under the age of 5 years, 15 (16.7%) were in hospital for over 35 days. None of the 25 patients in the age group 5-14 years were in over 35 days and only 1 of 17 flexner patients over 15 years was in for this period. Of the 144 sonne patients under 5 years, 15 (10.4%) were hospitalised for over 35 days. None of the 58 sonne patients in the age group 5-14 years was in for over 35 days but 3 elderly patients out of the 26 sonne patients over 15 years stayed in hospital over 35 days.

This indicates that the course of the disease is probably longer in children under 5 years and in elderly patients.

Cost of hospitalisation

An assessment was made of the approximate cost of hospitalisation of the 360 patients (Table 50). The average net cost per patient per week for an infectious disease hospital in the Western Regional Hospital Area of Scotland given on page 119 of the Scottish Health Statistics for 1966 was £38.10.11d, i.e. £5.10.1½d per patient per day. In the present survey, the total length of stay in hospital of all patients with flexner dysentery was 2,760 days and for patients with sonne dysentery 4,419 days. At £5.10.1½d per patient per day, the cost of all flexner patients was £15,197.5.0d and of all sonne patients £24,332.2.4½d, a total of £39,529.7.4½d or approximately £40,000 for the 360 patients.

This is an underestimation of the actual cost of hospitalisation during the period of the survey from April to November 1968 since the average net cost per patient for 1966 has been used in the above calculations as figures for later years have not yet been published.

The total cost of illness caused by dysentery is still higher as the above figures do not take into account the cost of medical care prior to hospital

admission given by general practitioners, the cost of social security benefits and the loss of production by employed patients.

SECTION V - RESISTANCE OF SHIGELLA TO ANTIMICROBIAL DRUGS

Resistance to Specific Drugs

The sensitivity of the various strains of Shigella was determined to 12 antimicrobial drugs. Standard methods were used for isolation of Shigella and the sensitivity was determined by disk-diffusion technique at suitable concentrations. Only sensitivity from the first culture from each patient was considered. Of the 12 drugs, the sensitivity to 8 was tested for in Belvidere and to 10 in Ruchill and only 6 of these drugs were common to both hospitals. In consequence the sensitivity of Shigella strains from all the 360 patients in the survey was tested to 6 drugs, viz. neomycin, sulphafurazole, ampicillin, colomycin, tetracycline and nalidixic acid. In addition strains of Shigella isolated from the 173 patients in Belvidere were tested against cephaloridine and kanamycin and strains of Shigella isolated from the 187 patients in Ruchill were tested against chloramphenicol, polymyxin B, streptomycin and paromomycin (Table 51).

(a) Resistance to neomycin, ampicillin, tetracycline, sulphafurazole, colomycin and nalidixic acid - (Table 52)

As already stated, the sensitivity of Shigella strains from all the 360 patients were tested to the above 6 drugs. Out of 132 strains of Sh. flexneri, 24 (18.2%) were resistant to neomycin, 24 (18.2%) to ampicillin, 36 (27.3%) to tetracycline and 122 (92.4%) to sulphafurazole. None of these strains was resistant to colomycin and nalidixic acid. Out of 228 strains of Sh. sonnei, 18 (7.9%) were resistant to neomycin, 81 (35.5%) to ampicillin, 79 (34.6%) to tetracycline and 213 (93.4%) to sulphafurazole. Only one strain was resistant to colomycin and none was resistant to nalidixic acid.

Thus all the strains of Shigella from the 360 patients were sensitive to nalidixic acid and only one sonne strain resistant to colomycin. 335 (93.1%) of the 360 strains were resistant to sulphafurazole and 115 (31.9%) to tetracycline.

(b) Resistance to cephaloridine and kanamycin - (Table 52)

The sensitivity of strains of Shigella isolated from all the 173 patients in Belvidere

Hospital was determined to cephaloridine and kanamycin in addition to the 6 antimicrobial drugs already mentioned. Of the 67 strains of Sh. flexneri, only 9 (13.4%) strains were resistant to cephaloridine and 9 (13.4%) to kanamycin whereas of 106 strains of Sh. sonnei, 40 (37.7%) were resistant to cephaloridine and 11 (10.4%) to kanamycin.

(c) Resistance to chloramphenicol, polymyxin B, streptomycin and paromomycin - (Table 52)

In addition to the 6 antimicrobial drugs, the sensitivity of strains of Shigella isolated from the 187 patients in Ruchill Hospital was determined to the above 4 drugs. Of 65 strains of Sh. flexneri, 9 (13.8%) were resistant to chloramphenicol, 2 (3.1%) to polymyxin B, 16 (24.6%) to streptomycin and 18 (27.7%) to paromomycin. Among the 122 strains of Sh. sonnei, 2 (1.6%) were resistant to chloramphenicol, 3 (2.5%) to polymyxin B, 87 (71.3%) to streptomycin and 7 (5.7%) to paromomycin. Thus strains of Sh. sonnei were predominantly resistant to streptomycin as compared with strains of Sh. flexneri

but resistance to chloramphenicol and paromomycin was greater among strains of Sh. flexneri than Sh. sonnei.

(d) Variations in drug resistance according to hospital - (Table 53)

30 (17.3%) of the 173 Shigella strains isolated in Belvidere Hospital were resistant to tetracycline whereas 85 (45.5%) of the 187 Shigella strains isolated in Ruchill Hospital were resistant to this drug. Hence of the 6 antimicrobial drugs tested for in both Belvidere and Ruchill, only tetracycline showed a pronounced difference in the percentages of resistant strains and this was largely due to the different concentrations of antimicrobial drugs used for testing in the two hospitals.

(e) Resistance of different serological types of Sh. flexneri - (Table 54)

From the 132 patients with flexner dysentery, Sh. flexneri type 3a was isolated from 75 patients, type X from 50, type 2a from 4, type 2 from 2, and type 6 from one patient. Of the 75 strains of Sh. flexneri type 3a, 73 (97.3%) were resistant

to sulphafurazole, 17 (22.6%) to tetracycline, 9 (12%) to ampicillin and 8 (10.7%) to neomycin. Of the 50 strains of Sh. flexneri type X, 44 (88%) were resistant to sulphafurazole, 18 (36%) to tetracycline, 15 (30%) to ampicillin and 16 (32%) to neomycin. Strains of types 2, 2a, and 6 were predominantly resistant to sulphafurazole.

Thus over 92% of strains of Sh. flexneri types 3a and X were resistant to sulphafurazole and a much lower percentage to tetracycline, ampicillin and neomycin. None of the strains of Sh. flexneri was resistant to colomycin or nalidixic acid.

(f) Specific resistance in relation to previous hospitalisation - (Table 54)

The sensitivity of Shigella strains isolated from those patients with previous admission to hospital on account of dysentery was determined. 10 (91%) of the 11 strains of Sh. flexneri were resistant to sulphafurazole, 3 (27.3%) to tetracycline and 2 (18.2%) to both ampicillin and neomycin respectively. Of the 20 strains

of Sh. sonnei isolated from patients previously hospitalised, 17 (85%) were resistant to sulphafurazole, 7 (35%) to tetracycline, 6 (30%) to ampicillin and none to neomycin.

Thus there were no appreciable differences in drug resistance between strains of Shigella flexneri and Shigella sonnei in those patients with a history of previous admission to hospital.

Multiple Resistance

It was found in the survey that the occurrence of multiple resistant strains of Shigella was common and that different combinations of drug resistance were often exhibited. Multiple resistance varied from 0 to 8 drugs among strains of Sh. flexneri and 0 to 7 drugs among strains of Sh. sonnei (Tables 55 and 56). A brief description is now given of the salient resistance patterns to the minimum and maximum number of drugs.

(a) Shigella flexneri

5 (3.8%) of the 132 strains of Sh. flexneri were resistant to none of the drugs. 79 (59.8%) were resistant to one drug and of these strains, 77 were resistant to sulphafurazole and 2 to streptomycin.

10 strains of Sh. flexneri type X were resistant to 7 drugs; 8 of these strains were resistant to chloramphenicol, streptomycin, neomycin, sulphafurazole, ampicillin, paromomycin and tetracycline and 2 resistant to cephaloridine, kanamycin, neomycin, sulphafurazole, ampicillin, paromomycin and tetracycline. One strain of Sh. flexneri type X was resistant to 8 of the 10 drugs.

Multiple resistance was highest among serological type X where over 20% of the 50 strains were resistant to 7 drugs.

(b) Shigella sonnei

Out of 228 strains of Sh. sonnei, only 3 (1.3%) strains were sensitive to all the drugs. 65 (28.5%) were resistant to only one drug viz. 60 to sulphafurazole and 5 to tetracycline. One strain was resistant to 7 of the 10 drugs.

Strains of Sh. flexneri show a higher proportion (7.2%) with multiple resistance to 7 drugs than strains of Sh. sonnei.

(c) Multiple resistance in relation to previous hospitalisation and age of patient

No characteristic multiple resistance patterns were found from strains of Shigella isolated from patients who had any previous admission to hospital on account of dysentery and similarly no relationship was found between the age of patient and the occurrence of multiple resistant strains (Tables 57 and 58).

Cross Resistance

Table 59 which records the cross-resistance found among Shigella strains shows that in Belvidere Hospital 20 out of 21 strains resistant to neomycin were also resistant to kanamycin and that in Ruchill Hospital a further 20 out of 21 strains resistant to neomycin were also resistant to paromomycin. Thus there was almost complete cross-resistance between neomycin and kanamycin and between neomycin and paromomycin. In Ruchill, 16 of the 21 strains of Shigella resistant to neomycin showed a one-way cross-resistance to streptomycin. In Belvidere 46 of the 53 strains of Shigella resistant to ampicillin showed complete cross-resistance to cephaloridine.

CHAPTER VI

DISCUSSION

SECTION I

"Cases" and "Controls"

Age distribution

Sex distribution

Social class

Social class and occupational state

Serological types of Shigella flexneri

Seasonal variations

Incidence of flexner dysentery in Glasgow in relation to Scotland and the United Kingdom

SECTION II

Housing circumstances

Sanitary facilities

SECTION III

Incidence of diarrhoea in schools

SECTION IV

Contacts

Hospitalisation for previous attacks of dysentery

Reasons for hospitalisation

Criteria of cure and length of stay in hospital

Health educational status

SECTION V

Resistance of Shigella to antimicrobial drugs

Specific drugs

Multiple resistance

Cross-resistance

Epidemiological significance of drug resistant Shigella strains

SECTION I

"Cases" and "Controls"

In this study of the epidemiology of bacillary dysentery with special reference to flexner dysentery, the object was to elicit any epidemiological factors which might account for the relatively high incidence of flexner dysentery in Glasgow. A preliminary retrospective study was carried out prior to the main survey to ascertain the incidence of the disease in Glasgow and to determine its relationship to the incidence in Scotland and in the United Kingdom as a whole. Following this a prospective survey was conducted of patients suffering from flexner dysentery who have been regarded as the "Cases" and who were contrasted with patients suffering from sonne dysentery, the "Controls", in an attempt to distinguish any differences in the epidemiological picture between the two series.

The retrospective study which covered all bacteriologically confirmed isolations from hospital and domiciliary patients for the whole of Glasgow showed that during the quinquennium 1962 to 1966 there were in that city between 20 to 56 patients with flexner for every one hundred patients with sonne dysentery.

In the prospective survey which considered hospital admissions exclusively, there were fifty-eight patients with flexner for every hundred with sonne dysentery. This high ratio of flexner to sonne isolations among hospital patients is a reflection of what pertains to the community at large in Glasgow i.e. a relative preponderance of flexner to sonne dysentery.

Age Distribution

Many observers including Charles and Warren (1929), Bojlen (1934), Bradley and Richmond (1956) and Eichner et al. (1968), have remarked that bacillary dysentery is common among children. Stein (1951) noted an increasing shift to the younger age groups in Scotland. Gillies (1956) observed that in Edinburgh the brunt of infection fell on those under fifteen years of age and of these, the one to four year age group bore the heaviest burden. Similarly Bloch (1938) and Carter and Young (1952) observed that in Glasgow dysentery was commonest in the younger age groups.

In the present survey, the age distribution of "Cases" and "Controls" confirmed a preponderance (88%) of children under fifteen years and in both

"Cases" and "Controls" the one to four year age group had the highest incidence of infection. There were no pronounced differences in all the age groups between flexner and sonne patients.

Sex Distribution

Stein (1951) reported that in Scotland the attack rate of bacillary dysentery in children was higher in males than in females but that, after fifteen to twenty years of age, the sex incidence is reversed. Carter and Young (1952) found that male children under five years accounted for 31% and female children 25.8% of the total notifications in Glasgow. Among children up to fifteen years, there was an excess of males over females but over that age, the sex ratio was markedly reversed.

In the present survey, an unexpected but possibly important finding was associated with the sex incidence among adults i.e. persons fifteen years and over. The age - sex specific rate of 17% for adult females with sonne dysentery was over three times higher than that of 5.5% for adult males whereas the age - sex specific rate of 13.6% for adult females with flexner dysentery was little different from that of adult

males (12.1%). Thus there was no rise in the male incidence of sonne dysentery in adult life but there was a rise in the male incidence of flexner dysentery. Gillies (1965) found a similar increase in Edinburgh among adult males with sonne dysentery and attributed this increase to the "type of society" - a study population of young families - in which his survey was conducted.

A probable explanation for the age - sex specific rate of adult males with flexner dysentery in the present study is that among flexner patients a high proportion of fathers were unemployed. In consequence they had increased opportunities, possibly as great as that of the mother, for nursing the sick child and of becoming infected.

Social Class

Bacillary dysentery has traditionally been associated with the least fortunate sections of the community. Manson-Bahr (1943) states that it was common in this country at times of squalor and deprivation and that epidemics tended to occur among the poorer classes. It is only in recent times however that the Registrar-General's Social Classification of Occupations has been applied to patients with bacillary dysentery. Some observers

including Macleod (1955) have noted that dysentery was more prevalent in the lower social classes. The social class distribution in the present survey showed that the highest incidence particularly of flexner patients occurred in social classes III, V and VI.

Social Class and Occupational State

Social class VI, i.e. persons unemployed for a period of over three months, was the largest social class among flexner patients and was 9.4% higher than among sonne patients. 42 fathers of flexner patients were unemployed and in consequence the majority of these households were receiving social security benefits.

In social class VI, none of the mothers of sonne patients and only two of the mothers of flexner patients were working full time. Where the mother is working full time and the father unemployed, there could be a greater chance of the father contracting infection from a child with flexner dysentery.

Serological types of Shigella flexneri

Different serological types of Shigella flexneri predominate in different parts of the world and even in the same country different serotypes are common during various decades. Bojlen (1934) found type 3a commonest in Denmark, Hart (1954) found type 2 commonest in Nigeria whilst Eichner et al. (1968) found type 2 commonest in the United States.

Carter and Young (1952) found type 2 commonest in Glasgow during 1937 to 1950 but in the present survey, Shigella flexneri type 3a, (56.8%), was commonest and type 2, (1.5%), met with infrequently. Thus there is a change in the serological type predominant in Glasgow in recent years. Gillies (1965) reported that "Shigella flexneri serotypes have virtually disappeared from Scotland but I suggest that the continuing periodicity of bacillary dysentery may be associated with the waxing and waning of different colicine types of Shigella sonnei". He also states that "one can submit the hypothesis that individual colicine types of Shigella sonnei may predominate in a community for a period of years and are then replaced by another type when the herd immunity of the human population to the original strain has risen to a certain level".

Although immunity to bacillary dysentery is variable, a similar hypothesis of predominance and replacement by another type when herd immunity alters could be advanced for the periodicity of different serological types of Shigella flexneri.

Seasonal Variations

Due to different criteria of evaluation such as the period of time studied and the geographical area considered, various observers have reached different conclusions on seasonal variations of bacillary dysentery. In discussing seasonal variations in Britain, Carter and Young (1952) state that "before the introduction of modern hygienic methods and public health measures when zymotic diseases ran an unhampered course, dysentery had a seasonal incidence greatest in the months of summer and early autumn. Epidemics occurred most often in warm weather, and if they appeared in winter usually displayed a decreased spreading power".

Scott (1938) considered the dysentery season in England and Wales to be from May to September. Glover (1947), in analysing the period September 1940 to November 1946 for England and Wales, produced a graph

which did not confirm the seasonal variation suggested by Scott. In 1949 Glover reported further that "rather unexpectedly the hot summer months have shown a comparatively low incidence but that Feburary, March and April had the highest incidence followed by September and October".

In Scotland, Sutherland (1943) recorded that seasonal changes have recently tended towards a high incidence in late summer. Stein (1951) produced diagrams showing that summer months had not produced the highest number of cases in Scotland but that, on the contrary, summer cases were fewer in number than those in earlier or later periods. Rae and Smith (1945), reporting on seasonal variation in the north eastern area of Scotland, stated that although the seasonal difference was at no time marked there was a higher incidence in the winter and spring months.

Bloch (1938) found that in Glasgow for the years 1935 to 1937 the incidence was greatest in the third and fourth quarters of the year and least in the second quarter. Carter and Young (1952) applying meteorological observations of the average mean monthly temperatures for Glasgow for the years 1938

to 1950 showed that the lowest incidence occurred in the coldest months of the year. They concluded that "the vagaries of dysentery in Glasgow have shown no eccentricities except perhaps in seasonal incidence".

It has been shown in Chapter III that the highest incidence of bacteriological isolations of Shigella flexneri and Shigella sonnei in the quinquennium 1962 to 1966 occurred in the fourth quarter of the year. In the present survey, which ran from April to November 1968, the highest monthly incidence was in May.

Incidence of flexner dysentery in Glasgow in relation to Scotland and the United Kingdom

After the First World War when dysentery became compulsorily notifiable in Britain, ex-servicemen returning from the Middle East with flexner dysentery were common. Glover (1947) stated that up to 1925 dysentery was described in the Reports of the Chief Medical Officer of the Ministry of Health as a "disease of exotic origin" whereas in the 1926 report it was placed in the chapter on "general epidemiology". In 1933 the Chief Medical Officer reported that "it is now well recognised that bacillary dysentery due to flexner and sonne infections is endemic in this

country" and later according to Glover (1947) bacteriological isolations in England and Wales showed a steady predominance of Shigella sonnei.

In Scotland, Rae and Smith (1945) discussing bacteriological isolations of Shigella in the north eastern region reported that sonne infection had been most prevalent during the whole period from 1929 to 1944. In more recent years, Gilles (1965) stated that of all diarrhoeas with a bacteriological aetiology, Shigella sonnei was by far the commonest accounting for 84.5% and Shigella flexneri a mere 0.4%. Such findings may possibly have led other observers including Cruickshank (1963) and Christie (1968) to conclude that bacillary dysentery is synonymous in this country with sonne dysentery.

However, in Glasgow the Annual Reports of the Medical Officer of Health from 1946 to 1967 show that in certain years isolations of Shigella flexneri outnumber those of Shigella sonnei. The high ratio of Shigella flexneri to Shigella sonnei in Glasgow compared with the ratios in Scotland and in the United Kingdom has been demonstrated in Chapter III where it was shown that for every hundred isolations of Shigella sonnei, there were between one to three

isolations of Shigella flexneri in the United Kingdom, three to twenty-five in Scotland and twenty to fifty-six in Glasgow. Thus Glasgow has a greater proportion of Shigella flexneri than the averages for Scotland and for the whole of the United Kingdom. Possible explanations for this are given later.

SECTION II

Housing Circumstances

Sanitary Facilities

In the present survey the majority of flexner patients lived in tenements with an outside water closet sited on the stairs or in the backcourt and these tenements also had no wash hand basins or fixed baths. Where there are no washing facilities or where if present these are remotely located in a room separate from the toilet, as occurred in the houses of most flexner patients, the opportunities for immediate washing of hands after using the toilet are considerably reduced. This confirms the observations of Hollister et al. (1955) who demonstrated that the incidence of Shigella was directly related to the availability of water for personal hygiene.

The majority of sonne patients lived in houses with their own inside water closet and adequate ancillary facilities. This basic but elemental difference in the type of house and its concomitant circumstances to that in which patients with flexner dysentery resided was very striking.

The greater the number of people using the water closet in an infected household the more probable the chance of the spread of infection in that household. This particularly applies where there are several children per water closet as was found among the households of flexner patients where almost 50% had a ratio of five children and over per water closet.

The high incidence of one or two apartments, the high children's occupancy, and the gross inadequacy of toilet facilities in such houses were more frequently found in flexner than sonne households. Such unsatisfactory housing conditions are especially favourable to the spread of the infection.

The report of the Scottish Housing Advisory Committee on Scotland's Older Houses (1967) states "Glasgow has a reputation for bad housing conditions and, despite great efforts by the Corporation, we have found that this reputation is unfortunately justified ..... Families are condemned to live in atrocious conditions which should shock the national conscience - and, we believe, would do so if they were better known. But even the Glaswegian who sees

only the often imposing (yet, on closer inspection, often crumbling) front exterior seldom appreciates how revolting and inhumane are the conditions inside the closes, on the common staircases, and in the back courts".

Anderson (1957) accounting for the high incidence of bacillary dysentery in Glasgow stated that "it would seem possible that the continued existence and use in Glasgow and Scotland generally of much substandard housing accommodation - especially poor in the adequacy of water closet arrangements - constitutes at least one important although only partial explanation".

There would seem no doubt that the unsatisfactory housing and living conditions found in the present survey are important factors especially conducive to the existence and spread of flexner dysentery and are important factors contributing to the high incidence of the disease in Glasgow.

SECTION III

Incidence of diarrhoea in schools

In the course of the survey, an explosive outbreak of diarrhoeal illness involving both pupils and teachers occurred in a primary school in a municipal ward (Knightswood) in Glasgow. Shigella sonnei was isolated from seventeen of the thirty-five patients admitted to hospital. Many of these patients considered that they had contracted the infection from a school dinner but the organism was not isolated from food or any member of the canteen staff.

This outbreak was responsible for the high incidence of sonne dysentery in this ward and also for the high percentage of sonne patients in the present survey who were aware that other children in their school had diarrhoea.

Enquiries were made to ascertain if, in the household of these seventeen sonne patients, persons in the household especially children not attending this school had become secondarily infected. Only in one household was a further child affected.

In this outbreak it did not appear that sonne dysentery contracted from the school secondarily infected other members of each patient's household to any appreciable extent.

SECTION IV

Contacts

Dysentery frequently affects most members of a family or household exposed to it. The present study showed that diarrhoea, a cardinal sign of dysentery, was widespread amongst other children in households where there was already a child who had flexner or sonne dysentery. Similar observations were noted by Pratt and Frew (1930) and Macleod (1955, 1958). Pratt and Frew observed that in one outbreak of dysentery in Glasgow Shigella flexneri was isolated from nineteen of the thirty-six patients. All the cases occurred in the same neighbourhood, many of them coming from the same street, and sixteen patients were from the same tenement. At a later date, Macleod showed that patients with sonne dysentery usually came from families already heavily infected. An attempt has been made in this survey to define more precisely the location and nature of each patient's contacts.

The major group of contacts outwith the patient's home was the school child. Preschool children constituted the majority of contacts in the households

of both flexner and sonne patients. Their mother however is frequently the first person who contracts the infection and because of close proximity facilitates spread of infection from herself to her children. In this study five parturient mothers suffering or recovering from sonne dysentery were in such a close contact that despite isolation and barrier nursing measures their infants developed within one week sonne dysentery of identical drug resistance pattern and colicine type as the mother.

All the contacts, adults, school children and preschool children, lived in Glasgow and only one of the one hundred and thirty-two patients with flexner dysentery had been out of Glasgow in the week preceding infection.

The above findings would indicate that the introduction of flexner dysentery into Glasgow from outside cannot account for the high incidence of the disease in that city.

Hospitalisation for Previous Attacks of Dysentery

A history of previous hospital admission on account of dysentery was given by thirty-one of the

three hundred and sixty patients and it is interesting to note that in all instances this occurred in children whose previous admissions had been within two years of the latest episode. During the course of the survey five patients were infected with flexner dysentery and a few months later readmitted to one of the two hospitals with either flexner or sonne infection.

These patients were undoubtedly convalescent carriers who were passing viable bacilli in their faeces. Such a group constitute an important reservoir of flexner dysentery from which other persons in the community can be readily infected. This is probably an important factor in the high incidence of the disease in Glasgow.

Reasons for hospitalisation

The reasons for admission to hospital on medical and social grounds and the criteria for classifying patients in accordance with the severity of illness vary with each observer and in consequence differing results are reported. The criteria used in the present survey have been described in the previous chapter. 59% of flexner and 54% of sonne patients

were admitted to hospital on medical grounds and in this group severely ill patients were 10.6% commoner among flexner than sonne patients.

Social reasons, which accounted for the admissions of 41% of flexner and 46% sonne patients, included unsatisfactory housing conditions, danger of infection to others, food handlers in household, elderly patients staying alone and persons transferred from residential institutions. Macleod (1955) stressed that social reasons must be taken into account in the admission of sonne patients into hospital especially among those in the lower social classes residing in old or crowded accommodation. Easton (1955), discussing the effect of hospital isolation in the control of dysentery in Glasgow, remarked that the housing conditions - overcrowded homes, shared water closets - of most of the patients were such that hospital isolation was essential.

The present survey confirms the above opinions in that, irrespective of the severity of the illness, almost 50% of all patients were admitted to hospital purely on social grounds.

Criteria of cure and length of stay in hospital

The criteria of cure required before discharge largely determine each patient's duration of stay in hospital. Various observers have used either bacteriological cure or clinical recovery as their criteria. On the whole it would appear that insistence on bacteriological clearance tends to prolong the length of stay in hospital especially among intermittent excretors whereas clinical recovery is generally of shorter duration.

Hardy and Watt (1944) noted that, irrespective of age of patient or severity of illness, infection usually persists beyond clinical recovery but they accepted only two negative consecutive daily cultures before discharging a patient. Cruickshank and Swyer (1940) and Osborn and Jones (1944) demanded three consecutive negative daily specimens and Eisenoff and Goldstein (1943) three successive negative specimens taken not less than forty-eight hours apart. Cooper and Keller (1950) obtained four negative daily stool cultures and Macleod (1955) twelve successive negative rectal swabs.

McFadzean and Stewart (1952) in their Hong Kong series of severe flexner dysentery insisted on negative specimens on three consecutive days followed by a clear terminal sigmoidoscopy whereas in the United States, Garfinkel et al. (1953) in their series of severe flexner dysentery patients regarded as free from infection those patients with a total of eight negative specimens and a clear terminal sigmoidoscopy.

Most observers accept three negative stool specimens taken on consecutive days after cessation of therapy as a reliable index of cure but some also rely on a clinical assessment of the patient. Clinical recovery was accepted by Easton (1955) who reported that permission was obtained to dismiss most patients with sonne dysentery after eleven days in Ruchill Hospital irrespective of the findings in the dismissal specimens. In consequence duration of stay in hospital was reduced.

In the present survey, the mean number of days in hospital was 22.2 per patient in Belvidere and 17.9 in Ruchill, a difference of 4.3 days. A probable explanation of this difference was that in Belvidere the criterion of three negative daily stool specimens after cessation of therapy was strictly applied whereas

in Ruchill clinical recovery rather than a strict bacteriological cure was often the major determining factor influencing hospital discharge.

Health educational status

A reduction in the incidence of bacillary dysentery may be effected by improvement in the health habits of affected individuals. Ordway (1960) pointed out that in the control of diarrhoeal diseases there is need for health education in three main areas - health awareness, sense of cleanliness, and mother efficiency.

Although in the present survey just over 50% of flexner and sonne patients were aware of the importance of personal hygiene especially cleanliness of hands, approximately 10% of both flexner and sonne patients were ignorant of any preventive measures against dysentery. Since the disease is prevalent among children and their standard of personal hygiene often low, the habit of thorough hand washing especially after using the toilet should be particularly encouraged. According to Beer, O'Donnell and Henderson (1966), a dysentery epidemic can be effectively controlled by such hygienic measures.

In the present survey all flexner and sonne patients living in houses with an outside water closet had no hand washing facilities in the toilets and in consequence their opportunities for immediate cleansing of hands were negligible. It has already been pointed out that the prevalence of Shigella is directly related to the availability of water for personal hygiene. Hence in this group of patients living in houses with an outside water closet the majority considered that having a house with adequate toilet and hand washing facilities is the most important preventive measure.

The results in the present survey show that even among patients who had had previous attacks of dysentery there is still scope for further health education. Seven of thirty-nine such patients had no idea of any preventive measures and it seems certain that these patients are important in the continuation and spread of the disease. It is therefore recommended that before discharge from hospital each patient (or the parent in case of a child) should be given a pamphlet of instructions on hygienic measures to prevent recurrence of the disease.

Where there are satisfactory toilet and hand washing facilities, the occurrence of flexner or sonne dysentery can only be attributed to the poor personal health standard of infected individuals. It is appreciated however that in the absence of satisfactory toilet and hand washing facilities instruction in hygienic practices is likely to be ineffective and this is especially relevant in children where standards taught at school cannot be applied in the home.

SECTION V

Resistance of Shigella to antimicrobial drugs

The successful treatment of bacillary dysentery involves the elimination of the infecting Shigellae by the use of antimicrobial drugs. As a result of exposure to such drugs Shigellae which are initially sensitive may become resistant, and in the laboratory Shigellae can be made resistant by growing them in the presence of progressively increasing but subinhibitory concentrations of antimicrobial drugs. Stewart (1962) states that all the available evidence indicates that the development of drug resistance is due to mutations and these mutations can occur spontaneously in cultures and independently of the presence of the drug.

Shigellae may rapidly become resistant in patients undergoing treatment with antimicrobial drugs probably due to selection by the drug of mutants having a high level of resistance. Such resistance may develop regardless of the amount of drug used.

In the control of drug resistant strains of Shigella a most important problem is that of preventing an increase of resistant strains in the human population. Since the prevalence of resistant strains is often a

direct result of the widespread use of antimicrobial drugs, this control can only be achieved by ensuring that such drugs are used effectively when the sensitivity of the organism is known.

Shigellae are sensitive "in vitro" to a number of drugs including sulphonamides, chloramphenicol, neomycin, paromomycin, kanamycin, polymyxin B, streptomycin, colomycin, ampicillin, cephaloridine, tetracycline and nalidixic acid. Shigella can readily develop resistance to any of these antimicrobial drugs and hence it is essential to know the sensitivity of the organism or at least the sensitivity pattern of an epidemic strain before embarking on treatment.

Although drug resistance varies from place to place, resistance to one or more drugs is now widely recognised. Discussion of the individual and multiple resistance patterns of Shigella strains and their epidemiological significance is now considered.

Specific Drugs

Sulphonamides

Soon after the discovery of the sulphonamides many workers found these drugs useful in the treatment of bacillary dysentery. Favourable results were

reported by Libby and Joiner (1940), Marshall (1941), Yannet et al. (1942), Eisenoff and Goldstein (1943) and Swyer and Yang (1945).

Within a decade however reports of sulphonamide resistant strains of Shigella had appeared. As early as 1950, Tateno (1950, 1951) recorded sulphonamide resistant strains of Shigella and later Cooper and Kellar (1950), Garfinkel et al. (1953), Johnson and Landsman (1957) and Adams (1960), described similar findings. Geddes and Sangster (1962) reporting on the antibiotic treatment of bacillary dysentery in Scotland found that 100% of the fifty-one strains of Shigella they tested were resistant to sulphonamides. A similar account was given by Elias-Jones and Wilson (1968) who found that in Glasgow the majority of Shigella strains were sulphonamide resistant.

In the present survey, over 90% of Shigella flexneri and Shigella sonnei strains were resistant to sulphonamides. It is apparent that in Glasgow Shigellae are no longer sensitive to sulphonamides and the use of these drugs for the treatment of bacillary dysentery in Glasgow should therefore be strongly discouraged.

Streptomycin

Although accounts of the success of oral streptomycin in the treatment of bacillary dysentery had been given by Macleod (1955) and Sangster (1956), the occurrence of Shigella resistant strains had been described previously. Forbes (1953) found that whereas streptomycin exerted a bactericidal action at a concentration of ten microgrammes, and that chloramphenicol, aureomycin and terramycin exerted a bacteriostatic effect, streptomycin produced resistance particularly in Shigella sonnei strains more readily than did the other antibiotics.

In the present survey 24.6% of Shigella flexneri were resistant to streptomycin compared with 71.3% of Shigella sonnei. Shigella sonnei strains were significantly different from Shigella flexneri strains in their resistance to streptomycin ($P << 0.001$). Many proprietary preparations for the treatment of bacillary dysentery advertised in the Monthly Index of Medical Specialities (MIMS June 1969) contain a mixture of sulphonamides and streptomycin. Such preparations will be valueless in the treatment of any sulphonamide-streptomycin resistant strains. The ease with which Shigella strains particularly those

of sonne develop resistance to streptomycin will limit still further any use of this drug in the treatment of bacillary dysentery in Glasgow.

Tetracycline

Tetracycline resistant strains of Shigella have been described by Geddes and Sangster (1962) who found fifty-eight of one hundred and four strains resistant. Moorhead and Parry (1965) reported that the tetracyclines were no longer of great use in the treatment of dysentery because of the development of resistant strains.

In the present survey almost one in every three Shigella strains was resistant to tetracycline. This fact limits future use of tetracycline in the treatment of both flexner and sonne dysentery especially when the sensitivity pattern of the organism has not been determined prior to commencing therapy.

Neomycin

Neomycin resistant strains of Shigellae are not so common. Geddes and Sangster (1962) found only two of sixty-eight strains resistant, Haltalin and Nelson (1965) only three of three hundred and forty strains

resistant to neomycin, and Moorhead and Parry (1965) reported only two resistant in their series of two hundred and seventy Shigella strains.

In the present study 18.2% of flexner strains compared with 7.9% of sonne strains were resistant to neomycin. This may be a reflection of the ease with which flexner strains become resistant to neomycin.

Ampicillin

In the present survey, 35% of Shigella sonnei strains were resistant to ampicillin compared with 18.2% of Shigella flexneri. Elias-Jones and Wilson (1968) reported that the development of resistant Shigella sonnei strains to ampicillin has occurred with great rapidity in Glasgow and is now a cause of concern as previously only sensitive strains had been isolated. In practice however ampicillin is not commonly used for the treatment of bacillary dysentery in Glasgow.

Colomycin

Resistant Shigella strains to colomycin are rare in Glasgow. No strain of Shigella flexneri and only one of Shigella sonnei in the present series was

resistant. Colomycin however is infrequently used in the treatment of bacillary dysentery.

Nalidixic acid

Not one of all the three hundred and sixty Shigella strains in the present survey was resistant to nalidixic acid. Nalidixic acid appears from in vitro and in vivo drug resistance findings to be the most appropriate drug for the treatment of both flexner and sonne dysentery in Glasgow.

Multiple Resistance

The determination of the sensitivities of strains of Shigella affords invaluable information as to the choice of the most suitable antimicrobial drug for treatment but the development of multiple resistant strains severely restricts any such choice.

Discussing the treatment of bacillary dysentery the British National Formulary, 1968, states that "antibacterial treatment will shorten the illness when the organism is sensitive but the recent spread of strains resistant to many or all of the antibiotics in current use has made the choice of drug extremely difficult. In many areas it is no longer worth

while initiating treatment without bacteriological information about the sensitivity of the organism".

In the present survey thirty-three of the three hundred and sixty Shigella strains showed multiple resistance to five or more drugs. Multiple resistance was highest with Shigella flexneri serological type X where ten of the fifty strains were resistant to seven drugs. Such findings obviously limits the choice of drug for treatment.

Drug resistance pattern and colicine typing as markers in epidemiology

In the school outbreak of dysentery in Knightswood already described all the seventeen patients were affected by Shigella sonnei colicine type O and all except two of the strains had the same multiple resistance to the three drugs, sulphonamides, tetracycline and streptomycin.

Other patients admitted before and after the outbreak from the same municipal ward had strains of different resistance patterns from that in the school outbreak. The difference in drug resistance and colicine type served to distinguish those who were involved in the school outbreak and allowed the course

of the epidemic to be followed. This feature supports the observations of Scrimgeour (1966) and his suggestion that drug resistance and colicine typing of Shigella may be used as markers in epidemiology.

Cross-Resistance

Crofton (1969) states "Cross-resistance is a term used to indicate that if a strain is resistant to one drug it is also resistant to another". He remarks further "If a particular drug has been unsuccessful in treating the patient's infection then there is usually little point in changing to another to which there may be cross-resistance.... In preventing acquired resistance by drug combinations there is little point in combining two drugs liable to cross-resistance as each may be ineffective against the mutants in the population resistant to the other".

These observations are borne out by the findings in the present survey which confirm that there was almost complete cross-resistance between neomycin, kanamycin and paromomycin and also between ampicillin and cephaloridine. A one-way cross-resistance was also demonstrated between neomycin and streptomycin.

Epidemiological significance of drug resistant Shigella strains

In summary therefore, the relationship between resistant Shigella strains and antimicrobial drugs is as follows:-

1. In Glasgow resistance is most common to sulphonamides and then to streptomycin, tetracycline, ampicillin and cephaloridine respectively. All flexner and sonne Shigella strains in this survey are sensitive to nalidixic acid and hence nalidixic acid appears to be the drug of choice for treatment of bacillary dysentery in Glasgow.

2. The development of multiple resistant strains is increasing and is already a cause of concern in Glasgow. In the present survey, one in every five strains of Shigella flexneri serological type X was resistant to seven drugs.

3. Shigella strains exhibit almost complete cross-resistance between neomycin, kanamycin and paromomycin and between ampicillin and cephaloridine. A one-way cross-resistance exists between neomycin and streptomycin.

4. Antimicrobial drug resistance pattern and colicine typing serve to characterise a particular isolate of Shigella thus determining its relationship to other endemic and epidemic strains and allowing the course of an outbreak to be charted.

CHAPTER VII

CONCLUSIONS

Prior to the main survey a retrospective study was carried out to ascertain the incidence of flexner dysentery in Glasgow and to determine its relationship to the incidence in Scotland and the United Kingdom as a whole.

THE RETROSPECTIVE STUDY

This study was chiefly concerned with notification rates of bacillary dysentery and the incidence of bacteriological isolations of Shigellae in the quinquennium 1962-1966. The main findings which emerged were as follows:-

1. During the fifty years period, 1919 to 1968 the highest incidence of bacillary dysentery in Scotland and also in Glasgow was in the 1954 to 1958 quinquennium. The highest annual notification rate for bacillary dysentery was in 1955 when the rates per hundred thousand population were two hundred and forty in Scotland and five hundred and eighty-seven in Glasgow respectively.

2. The notification rates in the thirty-seven municipal wards of Glasgow during the quinquennium 1962 to 1966 ranged from 0.26 to 8.75 per thousand population.

3. Bacteriological isolations in the same quinquennium reveal that there were one to three isolations of Shigella flexneri in the United Kingdom, three to twenty-five in Scotland, and twenty to fifty-six in Glasgow, for every hundred isolations of Shigella sonnei in these respective areas. Thus Glasgow has a greater proportion of Shigella flexneri than the averages for Scotland and for the whole of the United Kingdom.

4. The maximum incidence annually of both flexner and sonne dysentery during this quinquennium occurred usually in the fourth quarter of the year.

5. In this quinquennium serological type six of Shigella flexneri was commonest.

6. A comparison of the three cities, Birmingham, Glasgow and Liverpool, shows that Liverpool has a lower incidence whereas Glasgow and

Birmingham have each a higher incidence of flexner dysentery than the average value for the United Kingdom.

THE PRESENT SURVEY

The main findings of the present survey which consisted of an epidemiological investigation of three hundred and sixty patients - one hundred and thirty-two with flexner and two hundred and twenty-eight with sonne dysentery - and which was undertaken to elicit possible factors contributing to the high incidence of flexner dysentery in Glasgow were as follows:-

1. In this survey there were fifty-eight patients with flexner for every hundred with sonne dysentery.

2. Serological type 3a Shigella flexneri was the commonest type and accounted for 56.8% of all flexner isolations.

3. 88.1% of all flexner and sonne patients were children i.e. persons under fifteen years of age. The highest age-specific incidence was in the one to four year age group.

4. The age-sex specific rate for adult females with flexner dysentery was little different from that for adult males whereas this rate for adult females with sonne dysentery was over three times higher than that for adult males. This is possibly because in the series of flexner patients a high proportion of the fathers were unemployed.

5. The majority of both flexner and sonne patients were from social classes III, V and VI.

6. Three hundred and thirty-six (129 flexner and 207 sonne) of the three hundred and sixty patients lived in Glasgow and only three flexner and twenty-one sonne patients came from outside the city.

7. The number of patients in the thirty-seven municipal wards ranged between 0 to 17 for flexner and 0 to 29 for sonne patients and the mean number of flexner and sonne patients for the wards were 3.4 and 4.9 respectively.

8. The majority of flexner patients lived in tenements with an outside water closet sited on the stairs or in the backcourt and in addition all these houses had no wash hand basins or fixed baths.

9. A high incidence of one or two apartment houses, a high children's occupancy in such houses, and a gross inadequacy of toilet facilities were more frequently found in flexner than sonne households.

10. There would seem no doubt that the unsatisfactory housing and living conditions found in the present survey are important factors especially conducive to the existence and spread of flexner dysentery and probably contributing largely to the high incidence of the disease in Glasgow.

11. Diarrhoea a cardinal sign of dysentery was widespread amongst other children in households where there was already a child with flexner or sonne dysentery.

12. All contacts of flexner and sonne patients lived in Glasgow. Only one of the one hundred and thirty-two flexner patients had been out of Glasgow in the week preceding infection. These findings would appear to suggest that the introduction of flexner dysentery from sources outside Glasgow cannot account for the high incidence of the disease in the city.

13. Eleven of the one hundred and thirty-two flexner patients gave a history of previous hospitalisation due to dysentery. These patients were mostly convalescent carriers and must constitute an important reservoir of flexner dysentery. This is probably another factor for the high incidence of the disease in Glasgow.

14. 10% of all flexner and sonne patients had no idea of any preventive measures against dysentery and such persons are evidently important in the continuing spread of the disease.

15. In Glasgow social reasons accounted for hospital admission of 41% of flexner and 46% of sonne patients and included unsatisfactory housing conditions, danger of infection to others, food handlers in households, elderly patients staying alone and persons transferred from residential institutions.

16. The cost of hospitalisation of the three hundred and sixty patients in the present survey suffering from flexner and sonne dysentery was calculated at £39,529 i.e. almost forty thousand pounds.

17. In Glasgow, individual antimicrobial drug resistance of Shigella is commonest to sulphonamides and then to streptomycin, tetracycline, ampicillin and cephaloridine respectively.

18. Nalidixic acid appears to be the drug of choice for the treatment of bacillary dysentery in Glasgow. All the three hundred and sixty Shigella strains in the present survey were sensitive to this drug.

19. Shigella strains were found to exhibit cross resistance between certain antimicrobial drugs.

20. The development of multiple resistant strains of Shigella is already a cause of concern in Glasgow. One in every five strains of Shigella flexneri serological type X was found to be resistant to seven antimicrobial drugs.

21. The present survey demonstrates that antimicrobial drug resistance pattern and colicine typing can be used as markers to follow the course of a sonne dysentery outbreak.

REFERENCES - CHAPTER I

1. ABBOT, J.D. and SHANNON, R. (1958) J. Clin. Path. 11, 71. A method for typing Shigella sonnei, using colicine production as a marker.

2. ALLBUTT, C, (1921). Greek Medicine in Rome. p. 339.

3. ANDREWES, F.W. (1918). Lancet 1, 560. Dysentery bacilli. The differentiation of the true dysentery bacilli from allied species.

4. ARETAEUS THE CAPPADOCIAN, (a) The extant works of Aretaeus the Cappadocian. Edited and translated by Francis Adams. (Sydenham Society 1856) p. 353.

ARETAEUS, (b) Translation of Aretaeus. Translated from the original Greek by John Moffat. 1785. Logographic Press, London. Book II, Chapter IX. p. 241.

5. BOJLEN, KNUD. (1934). Dysentery in Denmark.

6. BOYD, JOHN SMITH KNOX (1947). The Mannitol-fermenting group of dysentery bacilli. M.D. Thesis, Glasgow University.

7. CASTELLANI, A. and CHALMERS, A.J. (1919). Manual of Tropical Medicine 3rd Edition p. 1824.

8. CLEGHORN, G. (1779). Observations on the epidemical diseases in Minorca from the year 1744 to 1749. 4th edition London. Chapter V. p. 244.

9. CREIGHTON, CHARLES (1891). A history of Epidemics in Britain revised by D.E.C. Eversley et al. 2nd edition 1965. Vols 1 and 11.

10. CHRISTIE, A.B. (1968). Brit. med. J. 2, 285. Bacillary dysentery.

11. EVANS, A.C. (1938). Lancet, 2, 187. Dysentery due to Bacterium dysenteriae (Schmitz).

12. FLEXNER, SIMON (1900)(a) Bull. Johns Hopk. Hosp. 11, 231. On the aetiology of tropical dysentery.

FLEXNER, SIMON (1900)(b)Brit. med. J. 2, 917. The aetiology of tropical dysentery.

13. HIPPOCRATES. The genuine works of Hippocrates. Vols. 1 and 11. Translated from Greek by Francis Adams (Sydenham Society 1849) Vol. 1. 1st and 3rd books of the epidemics p. 337.

14. LARGE, D.T.M. and SANKARAN, O.K. (1934) J. roy. Army Med. Cps. 63, 231. Dysentery among troops in Quetta. The non-mannite fermenting group of organisms.

15. MANSON-BAHR, SIR PHILIP (Kt). (1943). The Dysenteric Disorders. 2nd edition. London.

16. MURRAY, E.G.D. (1918). J. roy. Army Med. Cps. 31, 257. and 353. An attempt at classification of Bacillus dysenteriae.

17. OSLER, WILLIAM (1890). Bull. Johns Hopk. Hosp. 1, 53. On the amoeba coli in dysentery and in dysenteric liver abscess.

18. PRINGLE, SIR JOHN (Kt.) (1765). Observations on the diseases of the Army. 5th edition London p. 217.

19. REPORTS: International Bulletin of Bacteriological Nomenclature and Taxonomy. (1951) 1, 150. (1954) 4, 19. (1958) 8, 25, 32. (1967) 17, 53.

20. RODGERS, LEONARD (1913) Dysenteries, their differentiation and treatment.

21. SACHS, A. (1943). J. roy. Army Med. Cps. 80, 92. A report on an investigation into the characteristics of new types of non-mannitol fermenting bacilli isolated from cases of bacillary dysentery in India and Egypt.

22. SCOTT, HAROLD (1942). A history of Tropical Medicine. Vol. 11. p. 820.

23. SYDENHAM, THOMAS.(a) The works of Sydenham. Vols. 1 and 11 Translated from the Latin edition of Dr. Greenhill by R.G. Latham. (Sydenham Society 1848). Vol. 1 p. 166. Vol. 11. p. 263.

SYDENHAM, THOMAS.(b) Selected works of Thomas Sydenham M.D., by John D. Comrie 1922. Section IV Chapter 1 p. 45.

24. TOPLEY and WILSON's Principles of Bacteriology and Immunity. Revised by Wilson, G.S. and Miles, A.A. 1964. 5th edition. London.

REFERENCES - CHAPTER II

1. ARKWRIGHT, J.A., YORKE, W., PRIESTLEY, O.H., and GILMORE, W., (1916) Brit. med. J., 1,683. Examination of 50 Dysentery Convalescents for Carriers.

2. BARRATT, J.O.W., (1916) Brit. med. J., 2,617.

3. BLOCH, E. (1938) Brit. med. J., 1,836. Glasgow experience of increased dysentery prevalence.

4. BOJLEN, KNUD (1934) Dysentery in Denmark

5. BOWES, G.K. (1938) Brit. med. J. 1, 1092. Outbreak of Sonne dysentery due to consumption of milk.

6. BOYD, J.S.K. (1936) J. roy. Army Med. Cps. 66,1. A review of the dysentery bacilli of India with special reference to certain redently described types.

7. BRADLEY, W.H., and RICHMOND, A.E., (1956). Mth. Bull. Minist. Hlth Lab. Serv., 15, 2. Dysentery in England and Wales.

8. BUCHANAN, G.S. (1918) Lancet 2, 166 Study of an outbreak of bacillary dysentery.

9. CARTER, H.S., and YOUNG, J.L., (1952) Glasg. med. J. 33, 368. Account of dysentery in Glasgow 1937 - 1950.

10. CHRISTIE, A B. (1968). Brit. med. J. 2,285. Bacillary Dysentery.

11. EICHNER, E.R., GANGAROSA, E.J., and GOLDSBY, J.B. (1968). Amer. J. publ. Hlth. 58, 753. The current status of Shigellosis in the United States.

12. FAULDS, J.S., (1942) (a) Mth. Bull. Minist. Hlth Emerg. Lab. Serv. Vol. 1, July p. 6. Milk-borne outbreak of Sonne Dysentery.

FAULDS, J.S., (1943) (b) Mth. Bull. Minist. Hlth Emerg. Lab. Serv. 2,143. An outbreak of milk-borne dysentery at Silloth.

13. FLETCHER, W., (1917) (a) J. roy. Army med. Cps. 29,545 and 679. Report upon the bacteriological examination of 1,000 soldiers convalescent from diseases of the dysentery and Enteric groups.

FLETCHER, W., (1918) (b) Ibidem 30, 51. Report upon the bacteriological examination of 1,000 soldiers convalescent from diseases of the dysentery and Enteric groups.

14. FYFE, G.M., (1927) J. Hyg. (Lond) 26, 271. Milk-borne Sonne Dysentery.

15. GILLIES, R.R., (1956) Hlth Bull. (Edinb.) 14, 54. Bacillary dysentery.

16. GLOVER, J.A., (1947) (a) Mth. Bull. Minist. Hlth Lab. Serv. 6, 46. The enigma of notified dysentery.

GLOVER, J.A., (1949) (b) Ibidem 8, 138. The enigma of notified dysentery.

17. GREEN, C.A., and MACLEOD, M.C., (1943) Brit. med. J. 2,259. Explosive epidemic of Sonne dysentery.

18. HARDY, A.V., WATT, J., KOLODNY, M.H., and DECAPITO (1940) Amer. J. publ. Hlth. 30, 53. Studies of the Acute Diarrhoeal Diseases. Infections due to the Newcastle Dysentery Bacillus.

19. HARDY, A.V., DECAPITO, T., and HALBERT, S.P. (1948) Publ Hlth Rep. (Wash) 63, 685 cited by Top F.H. 1964 Communicable and Infectious Diseases. 5th edition.

20. HART, R.J.C. (1954) J. roy. Army Med. Cps. 100, 300. Bacillary dysentery in a station in Northern Nigeria.

21. HUDSON, N.P., (1922) J. Amer. med. Ass. 79, 1676. A case of persistent infection with B. dysenteriae (Flexner).

22. HUTCHISON, R.I., (1956) Mth. Bull. Minist. Hlth Lab. Serv. 15,110. Some observations on the method of spread of Sonne dysentery.

23. KENNEDY, A.M., and ROSEWARNE, D.D., (1916) Brit. med. J. 2,864. Observations upon dysentery carriers.

24. KINLOCH, J.P., (1923) J. Hyg. (Lond) 21,451. The Aberdeen epidemic of milk-borne bacillary dysentery. March - May 1919.

25. KUHNS, D.M., and ANDERSON, T.G., (1944) Amer. J. Publ. Hlth. 34,750. A fly-borne bacillary dysentery epidemic in a large Military Organization.

26. MACALISTER, G.H.K., (1910) Brit. med. J. 2, 1506. Dysentery Carriers.

27. MANSON-BAHR, P., The Dysenteric Disorders (1943) 2nd edition. London.

28. MEL, D.M., PAPO, R.G., TERZIN, A.C., and VUKSIC, L., (1965) Bull. Wld Hlth Org. 32, 633. Studies on vaccination against Bacillary dysentery.

29. ORDWAY, N.K., (1960) Bull. Wld Hlth Org. 23, 73. Diarrhoeal disease and its control.

30. PAUL, H. 1952. The control of Communicable Diseases. 1st edition. London p. 316.

31. PERRY, H.M. (1925) J. roy. Army Med. Cps. 45, 345. Laboratory research on Bacillary Dysentery.

32. RAE, H.J., and SMITH, J., (1945) Hlth Bull. (Edinb.) 4, 30. Milk-borne outbreak of Sonne Dysentery in Aberdeen.

33. REPORTS (1959) (a) Mth. Bull. Minist. Hlth Lab. Serv. 18, 86. (1965) (b) Ibidem 24, 376.

34. ROSS, A.I., and GILLESPIE, E.H., (1952) Mth. Bull. Minist. Hlth Lab. Serv. 11, 36. An outbreak of water-borne gastroenteritis and Sonne Dysentery.

35. SCOTT, H.H., 1934. Some Notable Epidemics p. 232 1st edition.

36. SEVERN, A.G.M., and EVANS, E.W., (1928) Lancet 1, 126. A localised outbreak of Bacillary dysentery in Smethwick.

37. SNADJER, K. (1954) Bull. Wld Hlth Org. 10, 77. A survey of Bacillary Dysentery in a rural community in Serbia.

38. STRONG, R.P., 1942 Stitt's Diagnosis, Prevention and Treatment of Tropical Diseases. Vol. 1. 6th edition. Philadelphia. p. 541.

39. SUTHERLAND, I.N., (1943)(a) Hlth. Bull. (Edinb) 2, 73. A short review of bacillary dysentery since 1931.

SUTHERLAND, I.N., (1945) (b) Ibidem 4, 8. A note on Bacillary Dysentery.

40. TAYLOR, J., (1960) Bull. Wld Hlth Org. 23, 763. The Diarrhoeal diseases in England and Wales.

41. TOP, F.H., 1964 Communicable and Infectious Diseases. 5th edition. p. 541.

42. TRIMBLE, C.J., and BROTHWOOD, W.C.U. (1938) Brit. med. J. 2, 1365. An outbreak of Sonne Dysentery.

43. WILSON and MILES 1964 Topley and Wilson's Principles of Bacteriology and Immunity. 5th edition. London.

REFERENCES - CHAPTER VI

1. ADAMS, A.R.D. (1960) Brit. med. J. 1, 1639. Bacillary dysentery.

2. BEER, B., O'DONNELL, G.M., and HENDERSON, R.J. (1966) Mth. Bull. Minist. Hlth. Lab. Serv., 25, 36. A school outbreak of sonne dysentery controlled by hygienic measures.

3. BLOCH, E. (1938) Brit. med. J., 1, 836. Glasgow experience of increased dysentery prevalence.

4. BOJLEN, KNUD (1934) Dysentery in Denmark. A contribution to the bacteriology and epidemiology of infection with sonne and flexner bacilli. Copenhagen, Printed by Bianco Lunos Bogtrykkeri A/S.

5. BRADLEY, W.H., and RICHMOND, A.E. (1956) Mth. Bull. Minist. Hlth. Lab. Serv., 15, 2. Dysentery in England and Wales.

6. British National Formulary (1968) Infections: Antibacterial preparations p. 103.

7. CARTER, H.S., and YOUNG, J.L. (1952) Glasg. med. J. 33, 368. Account of dysentery in Glasgow 1937 - 1950.

8. CHARLES, J.A. and WARREN, S.H. (1929) Lancet 2, 626. Bacillary dysentery in an industrial area.

9. CHRISTIE, A.B. (1968) Brit. med. J. 2, 285. Bacillary Dysentery.

10. COOPER, M.L., and KELLER, H.M. (1950) Amer. J. Dis. Child. 80, 911. Dysentery due to sulfonamide - resistant Shigella sonnei controlled with chloromycetin.

11. CROFTON, J. (1969). Brit. med. J. 2, 137, 209. Some principles in the Chemotherapy of Bacterial Infections I and II.

12. CRUICKSHANK,R. (1963) Diarrhoeal diseases in the United Kingdom. Epidemiology. Pemberton. Oxford University Press London p. 60.

13. CRUICKSHANK, R., and SWYER, R. (1940) Lancet 2, 803. An outbreak of sonne dysentery.

14. EASTON, H.G. (1955) Lancet 2, 241. Hospital isolation in the control of dysentery.

15. EICHNER, E.R., GANGAROSA, E.J., and GOLDSBY, J.B. (1968) Amer. J. publ. Hlth. 58, 753. The current status of Shigellosis in the United States.

16. EISENOFF, H.M., and GOLDSTEIN, H. (1943) J. Amer. med. Ass. 123, 624. Control of an outbreak of bacillary dysentery with sulfonamides.

17. ELIAS-JONES, T.F., and WILSON, W. (1968). Public Health Laboratory Service England. Communicable Disease Report 20, 1. Sonne Dysentery.

18. FORBES, G.B. (1953). Brit. med. J. 1, 1139. Sensitivity studies on Shigella sonnei.

19. GARFINKEL, B.T., MARTIN, G.M., WATT, J., PAYNE, F.J., MASON, R.P., and HARDY, A.V. (1953) J. Amer. med. Ass. 151, 1157. Antibiotics in acute bacillary dysentery.

20. GEDDES, A.M., and SANGSTER, G. (1962) Scot. med. J. 7, 409. Antibiotic treatment of bacillary dysentery.

21. GILLIES, R.R. (1956) Hlth. Bull. (Edinb.) 14, 54. Bacillary dysentery.

22. GILLIES, R.R. (1965) Milbank mem. Fd. Quart. Vol XLIII Number 2 Part 2 p. 224, Comparability in International Epidemiology. Longitudinal family studies in Scotland.

23. GILLIES, R.R. (1965) Bacteriocin Production : an epidemiologic marker of Shigella sonnei; Inter-regional type incidence. Nicht einzeln im Buchhandel! Uberreicht vom Verfasser Sonderdruck aus dem Zentralblatt fur Bakteriologie, Parasiten Kunde, Infektion skran Kheinten und Hygiene 1, Orig. 196. S. 370 - 377 (1965) Gustav Fisher Verlag, Stuttgart (Reprint in English obtainable from the author).

24. GLOVER, J.A. (1947) (a) Mth. Bull. Minist. Hlth, Lab. Serv. 6, 46. The enigma of notified dysentery.

25. GLOVER, J.A. (1949) (b) Ibidem 8, 138. The enigma of notified dysentery.

26. HALTALIN, K.C., and NELSON, J,D. (1965) J, Amer. med. Ass. 193, 705. In vitro susceptibility of Shigellae to sodium sulfadiazine and to eight antibiotics.

27. HARDY, A.V., and WATT, J. (1944) Amer. J. publ. Hlth. 34, 503. Newer procedures in Laboratory Diagnosis and therapy in the Control of Bacillary Dysentery.

28. HART, R.J.C. (1954) J. roy. Army Med. Cps. 100, 300. Bacillary dysentery in a station in Northern Nigeria.

29. HOLLISTER, A.C. Jr., BECK, M.D., GITTELSOHN, A.M. and HEMPHILL, E.C. (1955) Amer. J. publ. Hlth. 45, 354. Influence of water availability on Shigella prevalence in children of farm labor families.

30. JOHNSON, R., and LANDSMAN, J.B. (1957) Scot. Med. J. 2, 383. Antibiotic treatment in dysentery.

31. LIBBY, R.L., and JOYNER, (1940) J, infect. Dis. 67, 67. The action of sufathiazole on the colon - typhoid - dysenteriae group of organisms.

32. MACLEOD, R.C. (1955) Sonne Dysentery. An approach, M.D. Thesis. The University of Glasgow.

33. MACLEOD, R.C. (1958) Mth. Bull. Minist. Hlth. Lab. Serv., 17, 2. Sonne dysentery in Liverpool.

34. MANSON-BAHR, P. 1943. The Dysenteric Disorders 2nd Edition. London.

35. MARSHALL, E.K., BRATTON, A.C., EDWARDS, L.B., and WALKER, E. (1941) Bull. Johns Hopk. Hosp. 68, 94. Sulfanilylguanidine in the treatment of acute bacillary dysentery in children.

36. McFADZEAN, A.J.S., and STEWART, P.D. (1952). Lancet 2, 166. Chloramphenicol in acute Shigella dysentery.

37. MONTHLY INDEX of Medical Specialities MIMS June 1969 pp. 21 and 101.

38. MOORHEAD, P.J., and PARRY, H.E. (1965) Brit. med. J. 2, 913. Treatment of sonne dysentery.

39. ORDWAY, N.K. (1960) Bull. Wld. Hlth. Org. 23, 73. Diarrhoeal disease and its control.

40. OSBORN, W.H., and JONES, R.N. (1944) Lancet 2, 470. Sonne dysentery treated with sulphaguanidine.

41. PRATT, T.A., and FREW, H.W.O. (1930) Glasg. med. J. 113, 82. A clinical account of an outbreak in Glasgow of bacillary dysentery.

42. RAE, H.J., and SMITH, J. (1945) Hlth. Bull. (Edinb.)4, 30. Milk-borne outbreak of sonne dysentery in Aberdeen.

43. REPORTS, (a) Annual report of the Medical Officer of Health - Glasgow 1946 to 1967.
(b) Annual report on the work of the Infectious Diseases Hospital. Western Regional Hospital Board Scotland. T. Anderson 1957. Dysentery. p. 17.
(c) Report by a Sub-Committee of the Scottish Housing Advisory Committee 1967. Scotland's Older Houses p. 22 Her Majesty's Stationery Office - Edinburgh.

44. SANGSTER, G. (1956) Lancet 1, 723. Oral Streptomycin in bacillary dysentery.

45. SCOTT, W.M. (1938) Lancet 2, 796. Bacillary dysentery.

46. SCRIMGEOUR, G. (1966) Mth. Bull. Minist. Hlth. Lab. Serv. 25, 278. The ampicillin resistance of Shigella sonnei : its epidemiological value.

47. STEIN, L. (1951) Hlth. Bull. (Edinb.) 9, 17. Dysentery in Scotland in recent years.

48. STEWART, F.S. (1962) Bigger's handbook of bacteriology. 8th Edition. London.

49. SUTHERLAND, I.N. (1943) Hlth. Bull, (Edinb.) 2, 73. A short review of bacillary dysentery since 1931.

50. SWYER, R., and YANG, R.K.W. (1945) Brit. med. J. 1, 149. Sulphanilylbenzamide, sulphanilylamidobenzamide and succinyl sulphathiazole in the chemo-therapy of sonne dysentery.

51. TATENO, I. (1950) Japanese J. Exper. Med. 20, 795. Abstracts in Bulletin of Hygiene (1951) 26, 1061. Studies on the treatment of bacillary dysentery.
I. Resistance of Shigella organisms to sulfa drugs.

52. TATENO, I. (1951) Japanese J. Exper. Med. 21, 79. Abstracts in Bulletin of Hygiene (1952) 27, 123. Studies on the treatment of bacillary dysentery.
II. Evaluation of the effectiveness of streptomycin, chloramphenicol, aureomycin and terramycin in bacillary dysentery.

53. YANNET, H., LEIBOVITZ, A. and DEUTSCH, J.V. (1942) J. Amer. med. Ass. 120, 184. Sulfathiazole in epidemic sonne dysentery.

AN EPIDEMIOLOGICAL STUDY OF FLEXNER DYSENTERY IN GLASGOW.

THESIS

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VOLUME II

September, 1969.

Page

VOLUME II

LIST OF TABLES

CHAPTER III

CHAPTER V - SECTION I : DEMOGRAPHIC DATA

TABLE

SECTION II : HOUSING CIRCUMSTANCES

TABLE

APPENDIX TABLE 1

BACILLARY DYSENTERY SCOTLAND 1919 - 1968 (50 years period)

QUINQUENNIAL NOTIFICATION RATES

QUINQUENNIUM	TOTAL NOTIFICATIONS	TOTAL POPULATION	NOTIFICATION RATE PER 100,000 POPN.
1919 - 23	703	24 358 500	2.88
1924 - 28	751	24 294 600	3.09
1929 - 33	1792	24 298 700	7.37
1934 - 38	4876	24 822 800	19.64
1939 - 43	10948	24 079 900	45.46
1944 - 48	13984	24 385 500	57.34
1949 - 53	21667	25 516 500	84.91
1954 - 58	47049	25 600 700	183.78
1959 - 63	36286	25 925 600	139.96
1964 - 68	24674	25 975 200	94.99

APPENDIX TABLE 2.

BACILLARY DYSENTERY SCOTLAND 1919 - 1968 (50 years period)

ANNUAL NOTIFICATION RATES

YEARS	NUMBER OF NOTIFICATIONS	TOTAL NOTIFICATIONS IN QUIN-QUENNIUM	POPULATION	TOTAL POPULATION IN QUIN-QUENNIUM	NOTIFICATION RATE PER 100,000 POPN. IN QUIN-QUENNIUM	ANNUALLY
1919	217		4 823 000			4.49
1920	276		4 866 900			5.67
1921	108		4 882 500			2.21
1922	42		4 898 000			0.85
1923	60	703	4 888 100	24,358,500	2.88	1.22
1924	42		4 862 200			0.86
1925	52		4 867 100			1.06
1926	256		4 864 300			5.26
1927	187		4 853 100			3.85
1928	214	751	4 847 900	24,294,600	3.09	4.41
1929	274		4 832 200			5.67
1930	262		4 828 000			5.42
1931	364		4 843 000			7.51
1932	482		4 883 100			9.87
1933	410	1792	4 912 400	24,298,700	7.37	8.34
1934	298		4 934 300			6.03
1935	389		4 952 500			7.85
1936	770		4 966 300			15.50
1937	951		4 976 600			19.10
1938	2468	4876	4 993 100	24,822,800	19.64	49.42
1939	1132		5 006 700			22.60
1940	1888		4 841 200			38.99
1941	2429		4 819 400			50.40
1942	2515		4 751 000			52.93
1943	2984	10948	4 661 600	24,079,900	45.46	64.01

APPENDIX TABLE 2 (Contd.)

BACILLARY DYSENTERY SCOTLAND 1919 - 1968 (50 years period)

ANNUAL NOTIFICATION RATES

YEARS	NUMBER OF NOTIFICATIONS	TOTAL NOTIFICATIONS IN QUIN-QUENNIUM	POPULATION	TOTAL POPULATION IN QUIN-QUENNIUM	NOTIFICATION RATE PER 100,000 POPN. IN QUIN-QUENNIUM	NOTIFICATION RATE PER 100,000 POPN. ANNUALLY
1944	4373		4 673 600			93.97
1945	4811		4 673 900			102.93
1946	1887		4 900 800			38.50
1947	759		5 072 300			14.96
1948	2154	13984	5 084 900	24,385,500	57.34	42.36
1949	2293		5 098 900			44.97
1950	5075		5 114 500			99.22
1951	5302		5 102 500			103.90
1952	3368		5 100 800			66.02
1953	5629	21667	5 099 800	25,516,500	84.91	110.37
1954	10538		5 103 600			206.48
1955	12264		5 111 300			239.93
1956	8445		5 119 900			164.94
1957	8570		5 124 700			167.22
1958	7232	47049	5 141 200	25,600,700	183.78	140.66
1959	8649		5 162 600			167.53
1960	8048		5 177 700			155.43
1961	6498		5 183 800			125.35
1962	6939		5 197 000			133.51
1963	6152	36286	5 204 500	25,925,600	139.96	118.20
1964	5058		5 206 400			97.14
1965	7083		5 203 900			136.10
1966	4274		5 190 800			82.33
1967	4523		5 186 600			87.20
1968	3736	24674	5 187 500	25,975,200	94.99	72.01

APPENDIX TABLE 3

BACILLARY DYSENTERY GLASGOW 1919 - 1968 (50 years period)

QUINQUENNIAL NOTIFICATION RATES

QUINQUENNIUM	TOTAL NOTIFICATIONS	TOTAL POPULATION	NOTIFICATION RATE PER 100,000 POPN.
1919 - 23	264	5 353 863	4.93
1924 - 28	112	5 417 214	2.06
1929 - 33	479	5 442 657	8.80
1934 - 38	977	5 442 381	17.95
1939 - 43	1557	5 461 147	28.51
1944 - 48	4760	5 454 992	87.25
1949 - 53	10338	5 439 038	190.07
1954 - 58	24484	5 361 700	456.64
1959 - 63	18628	5 247 029	355.01
1964 - 68	9885	4 904 798	201.53

APPENDIX TABLE 4.

BACILLARY DYSENTERY GLASGOW 1919 - 1968 (50 years period)

ANNUAL NOTIFICATION RATES

YEARS	NUMBER OF NOTIFICATIONS	TOTAL NOTIFICATIONS IN QUIN-QUENNIUM	POPULATION	TOTAL POPULATION IN QUIN-QUENNIUM	NOTIFICATION RATE PER 100,000 POPN. IN QUIN-QUENNIUM	NOTIFICATION RATE PER 100,000 POPN. ANNUALLY
1919	117		1 061 695			11.02
1920	81		1 068 346			7.58
1921	46		1 075 000			4.27
1922	14		1 074 607			1.30
1923	6	264	1 074 215	5,353,863	4.93	0.55
1924	14		1 073 822			1.30
1925	12		1 073 429			1.11
1926	12		1 090 380			1.10
1927	29		1 089 988			2.66
1928	45	112	1 089 595	5,417,214	2.06	4.12
1929	119		1 089 202			10.92
1930	74		1 088 810			6.79
1931	79		1 088 461			7.25
1932	136		1 088 215			12.49
1933	71	479	1 087 969	5,442,657	8.80	6.52
1934	66		1 087 723			6.06
1935	135		1 087 476			12.41
1936	239		1 087 230			21.98
1937	275		1 086 984			25.29
1938	262	977	1 092 968	5,442,381	17.95	23.97
1939	163		1 092 722			14.91
1940	364		1 092 476			33.31
1941	319		1 092 229			29.20
1942	273		1 091 983			25.00
1943	438	1557	1 091 737	5,461,147	28.51	40.11

APPENDIX TABLE 4 (Contd).

BACILLARY DYSENTERY GLASGOW 1919 - 1968 (50 years period)

ANNUAL NOTIFICATION RATES

YEARS	NUMBER OF NOTIFICATIONS	TOTAL NOTIFICATIONS IN QUIN-QUENNIUM	POPULATION	TOTAL POPULATION IN QUIN-QUENNIUM	NOTIFICATION RATE PER 100,000 POPN. IN QUIN-QUENNIUM	NOTIFICATION RATE PER 100,000 POPN. ANNUALLY
1944	1259		1 091 491			115.34
1945	1474		1 091 245			135.07
1946	572		1 090 998			52.42
1947	277		1 090 752			25.39
1948	1178	4760	1 091 491	5 454 992	87.25	108.02
1949	1401		1 090 260			128.50
1950	2372		1 090 013			217.61
1951	1550		1 089 767			142.23
1952	2293		1 086 202			211.10
1953	2722	10338	1 082 796	5 439 038	190.07	251.38
1954	6242		1 079 311			578.33
1955	6319		1 075 825			587.36
1956	4628		1 072 340			431.57
1957	3918		1 068 855			366.56
1958	3377	24484	1 065 369	5 361 700	456.64	316.97
1959	4751		1 061 884			447.41
1960	4617		1 058 398			436.22
1961	3275		1 053 100			310.98
1962	3310		1 044 500			316.89
1963	2675	18628	1 029 147	5 247 029	355.01	259.92
1964	2584		1 018 582			253.68
1965	2104		1 000 857			210.21
1966	1782		979 798			181.87
1967	1632		960 527			169.90
1968	1783	9885	945 034	4 904 798	201.53	188.67

APPENDIX

TABLE 5.

SEASONAL INCIDENCE OF BACILLARY DYSENTERY IN GLASGOW FOR DECENNIUM 1957 - 1966

YEAR	1st QUARTER	2nd QUARTER	3rd QUARTER	4th QUARTER	TOTAL
1957	1225	1354	683	656	3918
1958	781	903	706	987	3377
1959	641	1232	1481	1397	4751
1960	1299	1214	1016	1088	4617
1961	631	770	662	1212	3275
1962	821	940	767	782	3310
1963	505	656	696	818	2675
1964	880	526	480	698	2584
1965	587	487	487	543	2104
1966	351	357	417	657	1782
Total	7721	8439	7395	8838	32393

APPENDIX

TABLE 6.

MUNICIPAL WARD DISTRIBUTION OF BACILLARY DYSENTERY IN QUINQUENNIUM 1962 - 1966

QUINQUENNIAL NOTIFICATION RATE PER 1000 POPULATION

IN DESCENDING ORDER	MUNICIPAL WARDS	RATES	IN DESCENDING ORDER	MUNICIPAL WARDS	RATES
1	Calton	8.75	21	Provan	1.76
2	Cowcaddens	6.74	22	Whiteinch	1.68
3	Dalmarnock	6.29	23	Govanhill	1.61
4	Kingston	6.25	24	Cowlairs	1.49
5	Mile-End	5.46	25	Fairfield	1.44
6	Woodside	5.21	26	Pollokshields	1.22
7	Hutcheson-town	4.96	27	Springburn	1.21
8	Exchange	4.39	28	Partick East	1.11
9	Anderston	4.07	29	Parkhead	1.06
10	Gorbals	3.99	30	Knightswood	0.82
11	Kinning Park	3.54	31	Cathcart	0.80
12	Townhead	3.46	32	Pollokshaws	0.77
13	Govan	2.61	33	Yoker	0.76
14	Partick West	2.57	34	Craighton	0.74
15	North Kelvin	2.49	35	Camphill	0.37
Average	for Glasgow	2.45	36	Kelvinside	0.33
16	Maryhill	2.41	37	Langside	0.26
17	Shettleston and Tollcross	2.35			
18	Ruchill	2.05			
19	Park	1.86			
20	Dennistoun	1.85			

APPENDIX TABLE 7.

SEROLOGICAL TYPES OF SHIGELLA FLEXNERI ISOLATED IN GLASGOW (1962 to 1966)

Year		Untyped	1	1a	1b	2	2a	2b	3	3a	4	4a	5a	6	X	Y	Total
1962	No	12	-	1	-	17	4	-	9	9	1	-	-	73	21	-	147
	%	8.1	-	0.7	-	11.6	2.7	-	6.1	6.1	0.7	-	-	49.7	14.3	-	100
1963	No	3	-	-	-	31	27	-	72	79	2	2	-	84	32	-	332
	%	0.9	-	-	-	9.3	8.1	-	21.7	23.8	0.6	0.6	-	25.3	9.7	-	100
1964	No	4	-	-	-	2	20	-	16	162	2	2	-	437	55	-	700
	%	0.6	-	-	-	0.3	2.9	-	2.3	23.1	0.3	0.3	-	62.4	7.8	-	100
1965	No	5	1	-	-	1	7	-	11	306	-	-	-	388	36	-	755
	%	0.7	0.1	-	-	0.1	0.9	-	1.5	40.5	-	-	-	51.4	4.8	-	100
1966	No	5	1	-	2	-	7	1	4	303	-	1	15	151	96	3	589
	%	0.9	0.2	-	0.3	-	1.2	0.2	0.7	51.4	-	0.2	2.5	25.6	16.3	0.5	100
Total	No	29	2	1	2	51	65	1	112	859	5	5	15	1133	240	3	2523
	%	1.15	0.08	0.04	0.08	2.02	2.57	0.04	4.44	34.05	0.2	0.2	0.59	44.91	9.51	0.12	100

TABLE 8.

DISTRIBUTION OF THE 360 "CASES" AND "CONTROLS"

	NUMBER	PERCENTAGE
Shigella flexneri (cases)	132	36.7
Shigella sonnei (controls)	228	63.3
Total	360	100.0

TABLE 9.

DISTRIBUTION OF "CASES" AND "CONTROLS" IN EACH HOSPITAL

	Belvidere		Ruchill		Total	
	No.	%	No.	%	No.	%
Shigella flexneri	67	38.7	65	34.8	132	36.7
Shigella sonnei	106	61.3	122	65.2	228	63.3
Total	173	100.0	187	100.0	360	100.0

TABLE 10.

HOSPITAL DISTRIBUTION AND TYPE OF INFECTION OF MALE AND FEMALE PATIENTS.

	Belvidere		Ruchill		Flexner		Sonne	
	No.	%	No.	%	No.	%	No.	%
Males	72	41.6	104	55.6	66	50	110	48.2
Females	101	58.4	83	44.4	66	50	118	51.8
Total	173	100.0	187	100.0	132	100	228	100.0

TABLE 11.

DISTRIBUTION OF SHIGELLA FLEXNERI BY SEROLOGICAL TYPE.

Types	2	2a	3a	6	X	Total
Numbers	2	4	75	1	50	132
Percentages	1.5	3.0	56.8	0.8	37.9	100

TABLE 12.

AGE AND SEX DISTRIBUTION OF PATIENTS

		-1	1-	2-	3-	4-	5-	6-	7-	8-	9-	10-	15+	Total
All ages		57	64	56	34	23	22	19	9	6	7	20	43	360
Flexner		17	25	25	12	11	7	7	5	1	2	3	17	132
Sonne		40	39	31	22	12	15	12	4	5	5	17	26	228
Flexner	Males	11	12	9	8	7	4	4	2	0	1	0	8	66
	Females	6	13	16	4	4	3	3	3	1	1	3	9	66
Sonne	Males	27	20	13	10	8	8	5	3	3	1	6	6	110
	Females	13	19	18	12	4	7	7	1	2	4	11	20	118
Males	Flexner & Sonne	38	32	22	18	15	12	9	5	3	2	6	14	176
Females	Flexner & Sonne	19	32	34	16	8	10	10	4	3	5	14	29	184

TABLE 13.

PERCENTAGE DISTRIBUTION BY AGE AND SEX OF PATIENTS.

		-1	1-	2-	3-	4-	5-	6-	7-	8-	9-	10-	15+	Total
All ages		15.8	17.8	15.6	9.4	6.4	6.1	5.3	2.5	1.7	1.9	5.6	11.9	100
Flexner		12.9	18.9	18.9	9.1	8.3	5.3	5.3	3.8	0.8	1.5	2.3	12.9	100
Sonne		17.5	17.1	13.6	9.6	5.3	6.6	5.3	1.8	2.2	2.2	7.4	11.4	100
Flexner	Males	16.7	18.2	13.6	12.1	10.6	6.1	6.1	3.0	0	1.5	0	12.1	100
	Females	9.1	19.7	24.2	6.1	6.1	4.6	4.6	4.5	1.5	1.5	4.5	13.6	100
Sonne	Males	24.5	18.2	11.8	9.1	7.3	7.3	4.5	2.7	2.7	0.9	5.5	5.5	100
	Females	11.0	16.1	15.3	10.2	3.4	5.9	5.9	0.8	1.7	3.4	9.3	17.0	100
Males	Flexner & Sonne	21.6	18.2	12.5	10.2	8.5	6.8	5.1	2.9	1.7	1.1	3.4	8.0	100
Females	Flexner & Sonne	10.3	17.4	18.5	8.7	4.4	5.4	5.4	2.2	1.6	2.7	7.6	15.8	100

TABLE 14.

NATIONALITY OF "CASES" AND "CONTROLS".

	Flexner		Sonne		Total	
	No.	%	No.	%	No.	%
1. Scottish	123	93.1	190	83.3	313	87.0
2. English & Welsh	3	2.3	5	2.2	8	2.2
3. Irish	4	3.0	9	3.9	13	3.6
4. West Indian	0	0	0	0	0	0
5. Indian & Pakistani	0	0	4	1.8	4	1.1
6. African	0	0	0	0	0	0
7. Others	1	0.8	4	1.8	5	1.4
Not known	1	0.8	16	7.0	17	4.7
Total	132	100.0	228	100.0	360	100.0

TABLE 15.

DISTRIBUTION OF PATIENTS BY SOCIAL CLASS.

Social Class	Flexner		Sonne		Total	
	No.	%	No.	%	No.	%
I	0	0	6	2.6	6	1.7
II	1	0.8	9	3.9	10	2.8
III	23	17.4	61	26.8	84	23.3
IV	20	15.1	31	13.6	51	14.2
V	40	30.3	44	19.3	84	23.3
VI	42	31.8	51	22.4	93	25.8
VII	5	3.8	8	3.5	13	3.6
VIII	1	0.8	18	7.9	19	5.3
Total	132	100.0	228	100.0	360	100.0

TABLE 16.

DISTRIBUTION IN RELATION TO EMPLOYMENT OF MOTHERS AND SOCIAL CLASS.

Mothers	Social Class	Flexner	Sonne	Total
		Numbers	Numbers	
Not employed	I	-	1	1
	II	1	4	5
	III	20	44	64
	IV	16	24	40
	V	31	38	69
	VI	38	41	79
	VII	-	5	5
	Total	106	157	263
Part-time employment	I	-	2	2
	II	-	1	1
	III	1	8	9
	IV	1	2	3
	V	4	3	7
	VI	-	2	2
	VII	-	-	-
	Total	6	18	24
Full time employment	I	-	1	1
	II	-	1	1
	III	-	3	3
	IV	-	1	1
	V	-	2	2
	VI	2	-	2
	VII	-	-	-
	Total	2	8	10
Not known				2
	Total	114	185	299

TABLE 17

MUNICIPAL WARD DISTRIBUTION OF PATIENTS WITH FLEXNER DYSENTERY.

Municipal Wards	No.	%	Municipal Wards	No.	%
1. Shettleston & Tollcross	4	3.0	21. Partick (West)	1	0.8
2. Parkhead	0	0	22. Whiteinch	1	0.8
3. Dalmarnock	9	6.8	23. Yoker	0	0
4. Calton	7	5.3	24. Knightswood	6	4.5
5. Mile-End	17	12.9	25. Hutchesontown	4	3.0
6. Dennistoun	0	0	26. Gorbals	0	0
7. Provan	13	9.8	27. Kingston	2	1.5
8. Cowlairs	2	1.5	28. Kinning Park	1	0.8
9. Springburn	13	9.8	29. Govan	6	4.5
10. Townhead	1	0.8	30. Fairfield	1	0.8
11. Exchange	2	1.5	31. Craigton	0	0
12. Anderston	6	4.5	32. Pollokshields	1	0.8
13. Park	2	1.5	33. Camphill	0	0
14. Cowcaddens	2	1.5	34. Pollokshaws	0	0
15. Woodside	2	1.5	35. Govanhill	3	2.3
16. Ruchill	1	0.8	36. Langside	2	1.5
17. North Kelvin	6	4.5	37. Cathcart	1	0.8
18. Maryhill	9	6.8			
19. Kelvinside	0	0	00 Outside Glasgow	3	2.3
20. Partick (East)	3	2.3	Inst. Institutional	1	0.8
			Mean No. of flexner patients	3.4	
			Total :	132	100%

TABLE 18.

MUNICIPAL WARD DISTRIBUTION OF PATIENTS WITH SONNE DYSENTERY

Municipal Wards	No.	%	Municipal Wards	No.	%
1. Shettleston & Tollcross	7	3.1	21. Partick (West)	3	1.3
2. Parkhead	2	0.9	22. Whiteinch	5	2.2
3. Dalmarnock	13	5.7	23. Yoker	5	2.2
4. Calton	5	2.2	24. Knightswood	29	12.7
5. Mile-End	8	3.5	25. Hutchesontown	2	0.9
6. Dennistoun	1	0.4	26. Gorbals	5	2.2
7. Provan	14	6.1	27. Kingston	0	0
8. Cowlairs	1	0.4	28. Kinning Park	1	0.4
9. Springburn	7	3.1	29. Govan	2	0.9
10. Townhead	6	2.6	30. Fairfield	2	0.9
11. Exchange	1	0.4	31. Craigton	1	0.4
12. Anderston	5	2.2	32. Pollokshields	0	0
13. Park	1	0.4	33. Camphill	2	0.9
14. Cowcaddens	11	4.8	34. Pollokshaws	3	1.3
15. Woodside	6	2.6	35. Govanhill	3	1.3
16. Ruchill	4	1.8	36. Langside	0	0
17. North Kelvin	9	4.0	37. Cathcart	4	1.8
18. Maryhill	7	3.1			
19. Kelvinside	2	0.9	00 Outside Glasgow	21	9.2
20. Partick (East)	5	2.2	Inst. Institutional	25	11.0
			Mean No. of Sonne patients	4.9	
			Total :	228	100%

TABLE 19

TYPE OF HOUSE OCCUPIED BY PATIENTS

	Flexner		Sonne		Total	
	No.	%	No.	%	No.	%
1. Tenement outside W.C.	70	53.0	75	32.9	145	40.3
2. Tenement inside W.C.	59	44.6	105	46.0	164	45.6
3. Terrace house	0	0	7	3.1	7	1.9
4. Villa	1	0.8	15	6.6	16	4.4
5. Multi-storey flat	0	0	1	0.4	1	0.3
6. Institution	1	0.8	25	11.0	26	7.2
7. Others	1	0.8	0	0	1	0.3
Total	132	100.0	228	100.0	360	100.0

TABLE 20

OWNERSHIP OF THE HOUSE

	Flexner		Sonne		Total	
	No.	%	No.	%	No.	%
1. Corporation	40	30.3	109	47.8	149	41.4
2. Private landlord	57	43.2	69	30.2	126	35.0
3. Self	34	25.7	46	20.2	80	22.2
4. Other Organisation	1	0.8	4	1.8	5	1.4
Total	132	100.0	228	100.0	360	100.0

TABLE 21

NUMBER OF ROOMS IN THE HOUSE

	Flexner		Sonne		Total	
	No.	%	No.	%	No.	%
1.	13	9.8	17	7.5	30	8.3
2.	64	48.5	73	32.0	137	38.1
3.	15	11.4	19	8.4	34	9.4
4.	25	18.9	37	16.2	62	17.2
5.	14	10.6	53	23.3	67	18.6
6.	0	0	5	2.2	5	1.4
7.	0	0	1	0.4	1	0.3
8.	0	0	1	0.4	1	0.3
9.	0	0	1	0.4	1	0.3
Institution	1	0.8	21	9.2	22	6.1
Total	132	100.0	228	100.0	360	100.0

TABLE 22

NUMBER OF CHILDREN IN RELATION TO NUMBER OF ROOMS IN THE HOUSE

No. of:		Flexner		Sonne	
Rooms	Children	Number	Percentage	Number	Percentage
1.	0	1	7.7	1	5.9
	1	3	23.1	4	23.6
	2	4	30.7	3	17.6
	3	3	23.1	5	29.4
	4	-	-	1	5.9
	5	1	7.7	-	-
	6	1	7.7	3	17.6
	Total	13	100.0	17	100.0
2.	0	1	1.6	1	1.4
	1	5	7.8	6	8.2
	2	11	17.2	13	17.8
	3	25	39.0	17	23.3
	4	11	17.2	15	20.5
	5	6	9.4	13	17.8
	6	2	3.1	6	8.2
	7	2	3.1	2	2.8
	8	-	-	-	-
	9	1	1.6	-	-
	Total	64	100.0	73	100.0
3.	0	-	-	-	-
	1	3	20.0	2	10.5
	2	1	6.7	5	26.3
	3	2	13.3	9	47.4
	4	2	13.3	-	-
	5	5	33.3	2	10.5
	6	1	6.7	-	-
	7	-	-	1	5.3
	8	-	-	-	-
	9	1	6.7	-	-
	Total	15	100.0	19	100.0
4.	0	1	4.0	3	8.1
	1	2	8.0	2	5.4
	2	5	20.0	8	21.6
	3	5	20.0	11	29.8
	4	-	-	8	21.6
	5	7	28.0	1	2.7
	6	4	16.0	1	2.7
	7	1	4.0	-	-
	8	-	-	-	-
	9	-	-	3	8.1
	Total	25	100.0	37	100.0
	Others	15	-	82	-

TABLE 23.

LOCATION OF WATER CLOSETS

	Outside Water Closet						Inside W.C.		No Information		Total	
	Stairs		Backcourt		Lobby							
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Flexner	51	38.6	18	13.6	1	0.8	61	46.2	1	0.8	132	100
Sonne	41	18.0	34	14.9	-	-	132	57.9	21	9.2	228	100
Total	92	25.6	52	14.4	1	0.3	193	53.6	22	6.1	360	100

TABLE 24

NUMBER OF FAMILIES SHARING WATER CLOSETS.

	Number of families										No information		Total	
	1		2		3		4		5					
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Flexner	61	46.2	19	14.4	39	29.5	10	7.6	2	1.5	1	0.8	132	100
Sonne	129	56.6	26	11.4	38	16.7	13	5.7	1	0.4	21	9.2	228	100
Total	190	52.8	45	12.5	77	21.4	23	6.4	3	0.8	22	6.1	360	100

TABLE 25

NUMBER OF CHILDREN PER WATER CLOSET

		Number of children per W.C.								No information	Total
		0	1	2	3	4	5	6	7+		
Flexner	No.	2	9	16	29	19	21	12	23	1	132
	%	1.5	6.8	12.1	22.0	14.4	15.9	9.1	17.4	0.8	100
Sonne	No.	5	13	25	38	38	15	25	45	24	228
	%	2.1	5.7	11.0	16.7	16.7	6.6	11.0	19.7	10.5	100
Total	No.	7	22	41	67	57	36	37	68	25	360
	%	1.9	6.1	11.4	18.6	15.9	10.0	10.3	18.9	6.9	100

TABLE 26

ADEQUACY OF OTHER TOILET FACILITIES

	Wash hand basin		Hot water system		Fixed bath	
	Present	Absent	Present	Absent	Present	Absent
Inside W.C.						
Flexner 61	37(60.7%)	24(39.3%)	42(68.9%)	19(31.1%)	37(60.7%)	24(39.3%)
Sonne 128	99(77.3%)	29(22.7%)	108(84.4%)	20(15.6%)	102(79.7%)	26(20.3%)
Outside W.C.						
Flexner 70	-	70 (100%)	10(14.3%)	60(85.7%)	-	70(100%)
Sonne 75	-	75 (100%)	11(14.7%)	64(85.3%)	-	75(100%)
Institution						
Flexner 1	Details not available					
Sonne 25	" " "					

TABLE 27

LOCATION OF WATER CLOSETS IN THE 37 MUNICIPAL WARDS

FLEXNER

Municipal Wards	Water Closets			Total
	Inside	Outside		
		Stairs	Backcourt	
1. Shettleston & Tollcross	2	1	1	4
2. Parkhead	-	-	-	-
3. Dalmarnock	2	6	1	9
4. Calton	4	2	1*	7
5. Mile-End	3	8	6	17
6. Dennistoun	-	-	-	-
7. Provan	13	-	-	13
8. Cowlairs	1	-	1	2
9. Springburn	3	10	-	13
10. Townhead	-	1	-	1
11. Exchange	1	-	1	2
12. Anderston	3	3	-	6
13. Park	2	-	-	2
14. Cowcaddens	-	2	-	2
15. Woodside	1	1	-	2
16. Ruchill	1	-	-	1
17. North Kelvin	1	4	1	6
18. Maryhill	1	7	1	9
19. Kelvinside	-	-	-	-
20. Partick (East)	1	2	-	3
21. Partick (West)	1	-	-	1
22. Whiteinch	1	-	-	1
23. Yoker	-	-	-	-
24. Knightswood	6	-	-	6
25. Hutchesontown	-	2	2	4
26. Gorbals	-	-	-	-
27. Kingston	1	-	1	2
28. Kinning Park	1	-	-	1
29. Govan	3	1	2	6
30. Fairfield	1	-	-	1
31. Craigton	-	-	-	-
32. Pollokshields	1	-	-	1
33. Camphill	-	-	-	-
34. Pollokshaws	-	-	-	-
35. Govanhill	2	-	1	3
36. Langside	2	-	-	2
37. Cathcart	-	1	-	1
Outside Glasgow	3	-	-	3
Institutional				1

* Situated in the lobby.

TABLE 28

LOCATION OF WATER CLOSETS IN THE 37 MUNICIPAL WARDS.

SONNE.

Municipal Wards	Water closets			Total
	Inside	Outside		
		Stairs	Backcourt	
1. Shettleston & Tollcross	2	1	4	7
2. Parkhead	2	-	-	2
3. Dalmarnock	-	9	4	13
4. Calton	3	2	-	5
5. Mile-End	1	3	4	8
6. Dennistoun	1	-	-	1
7. Provan	14	-	-	14
8. Cowlairs	1	-	-	1
9. Springburn	5	2	-	7
10. Townhead	3	1	2	6
11. Exchange	1	-	-	1
12. Anderston	4	-	1	5
13. Park	1	-	-	1
14. Cowcaddens	4	4	3	11
15. Woodside	1	3	2	6
16. Ruchill	3	-	1	4
17. North Kelvin	1	2	6	9
18. Maryhill	1	3	3	7
19. Kelvinside	2	-	-	2
20. Partick (East)	5	-	-	5
21. Partick (West)	3	-	-	3
22. Whiteinch	1	4	-	5
23. Yoker	5	-	-	5
24. Knightswood	29	-	-	29
25. Hutchesontown	-	1	1	2
26. Gorbals	5	-	-	5
27. Kingston	-	-	-	-
28. Kinning Park	-	-	1	1
29. Govan	-	1	1	2
30. Fairfield	-	1	1	2
31. Craigton	1	-	-	1
32. Pollokshields	-	-	-	-
33. Camphill	2	-	-	2
34. Pollokshaws	3	-	-	3
35. Govanhill	3	-	-	3
36. Langside	-	-	-	-
37. Cathcart	3	1	-	4
Outside Glasgow	18	3	-	21
Institutional				25

TABLE 29

NUMBER OF CHILDREN PER W.C. BY MUNICIPAL WARD

FLEXNER

Municipal Ward	Number of children per W.C.								
	0	1	2	3	4	5	6	7+	Total
1. Shettleston & Tollcross				1	2			1	4
2. Parkhead									-
3. Dalmarnock		1	1	3	1	1		2	9
4. Calton		1	1	4			1		7
5. Mile-End		1	1	4	3	6	1	1	17
6. Dennistoun									-
7. Provan	1	2	1	3		1	3	2	13
8. Cowlairs				1			1		2
9. Springburn			1		3	4		5	13
10. Townhead				1					1
11. Exchange		1	1						2
12. Anderston		1	1		3		1		6
13. Park				1		1			2
14. Cowcaddens					2				2
15. Woodside	1					1			2
16. Ruchill			1						1
17. North Kelvin			1	2			1	2	6
18. Maryhill		1			5	1	2		9
19. Kelvinside									-
20. Partick (East)				1		1		1	3
21. Partick (West)			1						1
22. Whiteinch				1					1
23. Yoker									-
24. Knightswood		1				5			6
25. Hutchesontown				1	1		2		4
26. Gorbals									-
27. Kingston			1	1					2
28. Kinning Park								1	1
29. Govan			1	2	1			2	6
30. Fairfield			1						1
31. Craigton									-
32. Pollokshields				1					1
33. Camphill									-
34. Pollokshaws									-
35. Govanhill			1	1				1	3
36. Langside		1		1					2
37. Cathcart				1					1
Outside Glasgow		1	2						3
Institutional									1

TABLE 30

NUMBER OF CHILDREN PER W.C. BY MUNICIPAL WARD

SONNE.

Municipal Ward	Number of children per W.C.								
	0	1	2	3	4	5	6	7+	Total
1. Shettleston & Tollcross		1		2	1	1		2	7
2. Parkhead							1	1	2
3. Dalmarnock		1		2				10	13
4. Calton			1	2			1	1	5
5. Mile-End					4	1	1	2	8
6. Dennistoun			1						1
7. Provan			1	1	5	2	1	4	14
8. Cowlairs				1					1
9. Springburn		1		2		1	2	1	7
10. Townhead	1		1	2				2	6
11. Exchange			1						1
12. Anderston			1	1				3	5
13. Park				1					1
14. Cowcaddens			1		4	1	3	2	11
15. Woodside		1		2		2	1		6
16. Ruchill		1	1	1				1	4
17. North Kelvin				3	1	1	2	2	9
18. Maryhill	1			2	2	2			7
19. Kelvinside	1		1						2
20. Partick (East)	1		3	1					5
21. Partick (West)					1		2		3
22. Whiteinch			1	1	3				5
23. Yoker	1			1	1		2		5
24. Knightswood		2	5	6	8	2	6		29
25. Hutchesontown		2							2
26. Gorbals				3	1	1			5
27. Kingston									-
28. Kinning Park								1	1
29. Govan				1	1				2
30. Fairfield					1	1			2
31. Craigton		1							1
32. Pollokshields									-
33. Camphill		1			1				2
34. Pollokshaws			1				1	1	3
35. Govanhill			2			1			3
36. Langside									-
37. Cathcart		1	1	1	1				4
Outside Glasgow	2	3	3	2	3		2	6	21
Institutional									25

TABLE 31

ADEQUACY OF OTHER TOILET FACILITIES IN THE MUNICIPAL WARDS

FLEXNER

Municipal Ward	Inside W.C. present	Outside W.C. present	Washhand basin present	Hot Water system present	Fixed bath present	Total No. patients in ward
1. Shettleston & Tollcross	2	2	2	2	2	4
2. Parkhead						-
3. Dalmarnock	2	7	-	2	-	9
4. Calton	4	3	-	1	-	7
5. Mile-End	3	14	2	3	2	17
6. Dennistoun						-
7. Provan	13	-	13	13	13	13
8. Cowlairs	1	1	1	1	1	2
9. Springburn	4	9	-	-	-	13
10. Townhead	-	1	-	1	-	1
11. Exchange	1	1	1	1	-	2
12. Anderston	3	3	-	2	-	6
13. Park	2	-	-	2	1	2
14. Cowcaddens	-	2	-	-	-	2
15. Woodside	1	1	-	-	-	2
16. Ruchill	1	-	1	1	1	1
17. North Kelvin	1	5	-	2	-	6
18. Maryhill	1	8	1	2	1	9
19. Kelvinside						-
20. Partick (East)	1	2	-	-	-	3

TABLE 31 (Continued)
ADEQUACY OF OTHER TOILET FACILITIES IN THE MUNICIPAL WARDS

FLEXNER

Municipal Ward	Inside W.C. present	Outside W.C. present	Washhand basin present	Hot Water system present	Fixed bath present	Total No. patients in ward
21. Partick(West)	1	-	-	-	-	1
22. Whiteinch	1	-	-	-	-	1
23. Yoker						-
24. Knightswood	6	-	6	6	6	6
25. Hutchesontown	-	4	-	-	-	4
26. Gorbals						-
27. Kingston	1	1	-	-	-	2
28. Kinning Park	1	-	-	1	-	1
29. Govan	3	3	2	3	3	6
30. Fairfield	1	-	1	-	1	1
31. Craigton						-
32. Pollokshields	1	-	1	1	1	1
33. Camphill						-
34. Pollokshaws						-
35. Govanhill	2	1	1	3	1	3
36. Langside	1	1	2	1	1	2
37. Cathcart	-	1	-	1	-	1
Outside Glasgow	3	-	3	3	3	3
Institutional						1

TABLE 32
ADEQUACY OF OTHER TOILET FACILITIES IN THE MUNICIPAL WARDS

SONNE

Municipal Ward	Inside W.C. present	Outside W.C. present	Washhand basin present	Hot water system present	Fixed bath present	No. of patients in ward
1. Shettleston & Tollcross	2	5	2	3	2	7
2. Parkhead	2	-	2	2	2	2
3. Dalmarnock	-	13	-	-	-	13
4. Calton	3	2	1	1	1	5
5. Mile-End	1	7	-	1	-	8
6. Dennistoun	1	-	1	1	1	1
7. Provan	14	-	14	14	14	14
8. Cowlairs	1	-	-	1	-	1
9. Springburn	5	2	5	6	5	7
10. Townhead	3	3	-	2	-	6
11. Exchange	1	-	-	-	-	1
12. Anderston	4	1	-	1	-	5
13. Park	1	-	-	1	-	1
14. Cowcaddens	4	7	3	5	4	11
15. Woodside	1	5	-	3	-	6
16. Ruchill	3	1	3	3	3	4
17. North Kelvin	1	8	1	1	-	9
18. Maryhill	1	6	1	3	1	7
19. Kelvinside	2	-	2	2	2	2
20. Partick (East)	5	-	4	4	4	5

TABLE 32 (Continued)

ADEQUACY OF OTHER TOILET FACILITIES IN THE MUNICIPAL WARDS

SONNE

Municipal wards	Inside W.C. present	Outside W.C. present	Washhand basin present	Hot water system present	Fixed bath present	No. of patients in ward
21. Partick (West)	3	-	-	-	-	3
22. Whiteinch	1	4	-	1	-	5
23. Yoker	1	4	1	1	1	5
24. Knightswood	29	-	29	29	29	29
25. Hutchesontown	-	2	-	-	-	2
26. Gorbals	5	-	2	4	3	5
27. Kingston						-
28. Kinning Park	-	1	-	-	-	1
29. Govan	-	2	-	1	-	2
30. Fairfield	-	2	-	1	-	2
31. Craigton	1	-	1	1	1	1
32. Pollokshields						-
33. Camphill	2	-	2	2	2	2
34. Pollokshaws	3	-	3	3	3	3
35. Govanhill	3	-	1	2	1	3
36. Langside						-
37. Cathcart	3	1	2	3	3	4
Outside Glasgow	18	3	15	16	16	21
Institutional						25

TABLE 33

INCIDENCE OF DIARRHOEA IN HOUSEHOLDS OF PATIENTS

Age Groups		Flexner Numbers	Flexner Percentages	Sonne Numbers	Sonne Percentages
-1	Diarrhoea	45	72.6	95	68.3
	Exposed	62		139	
1	Diarrhoea	59	78.7	87	56.5
	Exposed	75		154	
2-4	Diarrhoea	113	68.1	171	75.7
	Exposed	166		226	
5-9	Diarrhoea	63	77.8	68	59.1
	Exposed	81		115	
10-15	Diarrhoea	6	85.7	23	41.1
	Exposed	7		56	
	Total	286	73.1	444	64.3
		391		690	

TABLE 34

HOSPITALISATION FOR PREVIOUS ATTACKS OF DYSENTERY

	Previous attacks of dysentery	Previous hospitalisation	No. of times admitted to hospital			
			1	2	3	4+
Flexner	13	11	9	-	1	1
Sonne	26	20	16	4	-	-

TABLE 35

APPROXIMATE DURATION OF SYMPTOMS BEFORE PRESENT HOSPITAL ADMISSION

	Symptom-less	Same day <24 hrs.	Duration of symptoms in days					Not known	Total
			1 day	-7	7-	14-	21-	28+		
Flexner	7	19	37	44	18	1	2	2	2	132
% of flexner	5.3	14.4	28.0	33.3	13.7	0.8	1.5	1.5	1.5	100
Sonne	52	39	52	59	13	4	4	4	1	228
% of sonne	22.8	17.1	22.8	25.8	5.7	1.8	1.8	1.8	0.4	100
Total	59	58	89	103	31	5	6	6	3	360
	16.4	16.1	24.7	28.6	8.6	1.4	1.7	1.7	0.8	100

TABLE 36

CONTACT WITH PERSONS SUFFERING FROM DIARRHOEA

	Patients with contacts	No contacts	Not known	No information	Total
Flexner	62(46.9%)	68	1	1	132
Sonne	90(39.5%)	122	1	15	228

TABLE 37

LOCATION AND NATURE OF CONTACTS

		Flexner (62)	Sonne (90)
Contacts living in house of patient	Preschool child	17 (27.4%)	32 (35.6%)
	School child	8 (12.9%)	3 (3.3%)
	Adult	6 (9.7%)	7 (7.8%)
	Preschool + school child	2 (3.2%)	1 (1.1%)
	School child + adult	- -	- -
	Total	33 (53.2%)	43 (47.8%)
Contacts not living in house of patient but in Glasgow	Preschool child	7 (11.3%)	20 (22.2%)
	School child	15 (24.2%)	22 (24.5%)
	Adult	5 (8.1%)	1 (1.1%)
	Preschool + school child	2 (3.2%)	2 (2.2%)
	School child + adult	- -	1 (1.1%)
	Preschool child + adult	- -	1 (1.1%)
	Total	29 (46.8%)	47 (52.2%)
Contacts living outside Glasgow	-	-	-

TABLE 38

ABSENCE FROM GLASGOW IN THE WEEK PRECEDING INFECTION.

Patients absent from Glasgow

	Elsewhere in Scotland	Elsewhere in England	Abroad	Patients not absent from Glasgow	Not known	Total
Flexner	1 (0.8%)	-	-	127(96.2%)	4(3%)	132
Sonne	4 (1.7%)	2 (0.9%)	-	193(84.7%)	29(12.7%)	228

TABLE 39

PATIENT'S AWARENESS OF SOURCE OF INFECTION

	Known	Not Known	No information	Total
Flexner	26(19.7%)	105(79.5%)	1 (0.8%)	132
Sonne	30(13.2%)	184(80.7%)	14 (6.1%)	228

TABLE 40

PATIENT'S OPINION OF FOOD AS THE PROBABLE SOURCE OF INFECTION

	Food was a factor		No information	Total
	Yes	No		
Flexner	6 (4.5%)	125 (94.7%)	1 (0.8%)	132
Sonne	8 (3.5%)	202 (88.6%)	18 (7.9%)	228

TABLE 41

HEALTH EDUCATIONAL STATUS IN RELATION TO THE PREVENTION OF DYSENTERY

	Flexner (132)	Sonne (228)
Washing of hands after using the W.C.	74 (56.0%)	123 (53.9%)
Living in a house with a bathroom, washhand basin and inside W.C.	41 (31.0%)	61 (26.8%)
No idea	14 (10.6%)	22 (9.7%)
Taking a well-balanced diet	1 (0.8%)	4 (1.8%)
Any other factors	1 (0.8%)	1 (0.4%)
Taking vitamins	- -	1 (0.4%)
No information available	1 (0.8%)	16 (7.0%)

TABLE 42

HEALTH EDUCATIONAL STATUS IN RELATION TO SOCIAL CLASS DISTRIBUTION

			Washing of hands after using the W.C.	Living in a good house with F.B. W.H.B. and ins. W.C.	No Idea	Taking a well balanced diet	Any Other Factors	Taking Vitamins	No information available
Flexner		I	-	-	-	-	-	-	-
	1	II	1	-	-	-	-	-	-
	23	III	18	4	1	-	-	-	-
Social	20	IV	6	11	2	-	1	-	-
Class	40	V	21	16	2	1	-	-	-
	42	VI	27	8	7	-	-	-	-
	5	VII	1	2	2	-	-	-	-
	1	VIII	-	-	-	-	-	-	1
Sonne	6	I	5	1	-	-	-	-	-
	9	II	7	1	-	-	1	-	-
	61	III	38	14	7	2	-	-	-
Social	31	IV	24	7	-	-	-	-	-
Class	44	V	24	12	7	-	-	1	-
	51	VI	21	23	5	2	-	-	-
	8	VII	4	3	1	-	-	-	-
	18	VIII	-	-	2	-	-	-	16

TABLE 43

HEALTH EDUCATIONAL STATUS IN RELATION TO ADEQUACY OF TOILET FACILITIES AND TO PREVIOUS ATTACKS OF DYSENTERY

Adequacy of toilet facilitites	Washing of hands after using the W.C.	Living in a good house with bath-room, W.H.C. & ins. W.C.	No Idea	Taking a well balanced diet	Any Other Factors	Taking Vitamins	No information available
Flexner							
61 Inside W.C.	41	13	5	1	1	-	-
51 W.C. on stairs	21	21	9	-	-	-	-
18 W.C. in backcourt	11	7	-	-	-	-	-
1 W.C. in lobby	1	-	-	-	-	-	-
1 No information	-	-	-	-	-	-	1
Sonne							
132 Inside W.C.	96	20	10	4	1	1	-
41 W.C. on stairs	13	25	3	-	-	-	-
34 W.C. in backcourt	11	16	7	-	-	-	-
- W.C. in lobby	-	-	-	-	-	-	-
21 No information	-	-	-	-	-	-	21
Previous attacks of dysentery							
Flexner 13	11	2	-	-	-	-	-
Sonne 26	11	6	7	-	-	-	2

TABLE 44

REASONS FOR HOSPITALISATION

	Flexner (132)	Sonne (228)
Medical:		
Patients severely ill	58 (43.9%)	76 (33.3%)
Incidental isolation of Shigella while in hospital from some other illness	20 (15.2%)	48 (21.1%)
Total:	78 (59.1%)	124 (54.4%)
Social:		
Danger of infecting others at home	30 (22.7%)	40 (17.5%)
Housing conditions	6 (4.6%)	8 (3.5%)
Parents or guardian working full time	- -	- -
Presence of food-handlers in the house	- -	1 (0.4%)
Institutional transfer	2 (1.5%)	5 (2.2%)
Any other reasons	16 (12.1%)	50 (22.0%)
Total:	54 (40.9%)	104 (45.6%)

TABLE 45

LENGTH OF STAY IN HOSPITAL

	Length of stay in hospital in days										
	1-3	4-6	7-	14-	21-	28-	35-	42-	49-56	99	Total
Flexner	4	4	24	43	26	15	10	4	1	1	132
Percentages	3.0	3.0	18.2	32.6	19.7	11.3	7.6	3.0	0.8	0.8	100
Sonne	5	5	49	89	47	15	10	6	1	1	228
Percentages	2.2	2.2	21.5	39.0	20.6	6.7	4.4	2.6	0.4	0.4	100

TABLE 46

LENGTH OF STAY IN BELVIDERE OR RUCHILL HOSPITAL

	Length of stay in hospital in days										
	1-3	4-6	7-	14-	21-	28-	35-	42-	49-56	99	Total
Flexner											
Belvidere	2	3	6	26	13	7	5	3	1	1	67
%	3.0	4.5	8.9	38.8	19.4	10.4	7.5	4.5	1.5	1.5	100
Ruchill	2	1	18	17	13	8	5	1	-	-	65
%	3.1	1.5	27.7	26.2	20.0	12.3	7.7	1.5	-	-	100
Sonne											
Belvidere	1	1	8	47	29	9	6	4	1	-	106
%	0.9	0.9	7.6	44.3	27.4	8.5	5.7	3.8	0.9	-	100
Ruchill	4	4	41	42	18	6	4	2	-	1	122
%	3.3	3.3	33.6	34.4	14.8	4.9	3.3	1.6	-	0.8	100

TABLE 47

MEAN LENGTH OF STAY IN HOSPITAL

	Flexner	Sonne
Number of patients	132	228
Total days in hospital	2760	4419
Mean No. of days per patient	20.9	19.4

	Belvidere	Ruchill	Belvidere	Ruchill
Number of patients	67	65	106	122
Total days in hospital	1508	1252	2327	2092
Mean No. of days per patient	22.5	19.3	22.0	17.1

	Belvidere	Ruchill
Total number of patients	173	187
Total days in hospital	3835	3344
Mean No. of days per patient	22.2	17.9

TABLE 48

LENGTH OF STAY IN RELATION TO AGE OF PATIENT (FLEXNER)

Flexner Age Groups	Length of stay in hospital in days										
	1-3	4-6	7-	14-	21-	28-	35-	42-	49-56	99	Total
-1	1	-	2	4	3	4	2	1	-	-	17
1-	1	-	-	10	5	4	2	2	1	-	25
2-	-	-	2	10	8	2	2	1	-	-	25
3-	1	-	2	2	3	3	1	-	-	-	12
4-	-	-	-	5	2	1	3	-	-	-	11
5-	-	-	3	3	1	-	-	-	-	-	7
6-	-	-	2	2	2	1	-	-	-	-	7
7-	-	-	4	-	1	-	-	-	-	-	5
8-	-	-	-	-	-	1	-	-	-	-	1
9-	-	1	-	1	-	-	-	-	-	-	2
10-14	-	-	1	2	-	-	-	-	-	-	3
15+	1	3	9	2	1	-	-	-	-	1	17

TABLE 49

LENGTH OF STAY IN RELATION TO AGE OF PATIENT (SONNE)

Sonne Age Groups	Length of stay in hospital in days										
	1-3	4-6	7-	14-	21-	28-	35-	42-	49-56	99	Total
-1	-	1	2	18	7	4	5	3	-	-	40
1-	3	1	5	12	11	6	1	-	-	-	39
2-	-	-	4	12	10	1	2	2	-	-	31
3-	-	1	5	6	6	2	2	-	-	-	22
4-	-	-	4	5	2	1	-	-	-	-	12
5-	-	-	1	8	5	1	-	-	-	-	15
6-	-	-	5	6	1	-	-	-	-	-	12
7-	-	-	2	2	-	-	-	-	-	-	4
8-	-	-	1	4	-	-	-	-	-	-	5
9-	-	-	2	3	-	-	-	-	-	-	5
10-14	1	1	10	3	2	-	-	-	-	-	17
15+	1	1	8	10	3	-	-	1	1	1	26

TABLE 50

COST OF HOSPITALISATION

	Flexner	Sonne	Total
Number of patients	132	228	360
Total days in hospital	2760	4419	7179
Mean No. of days per patient	20.9	19.4	19.9
Average net cost/patient/day	£5:10:1½d	£5:10:1½d	£5:10:1½d
Total cost of all patients	£15,197: 5: 0d	£24,332: 2: 4½d	£39,529: 7: 4½d
Gross estimated cost			£40,000.

TABLE 51

HOSPITAL DISTRIBUTION OF SHIGELLA STRAINS TESTED AGAINST ANTIMICROBIAL DRUGS

	Flexner	Sonne	Flexner		Sonne	
			Belvidere	Ruchill	Belvidere	Ruchill
Chloramphenicol	65	122	-	65	-	122
Polymyxin B	65	122	-	65	-	122
Streptomycin	65	122	-	65	-	122
Paromomycin	65	122	-	65	-	122
Cephaloridine	67	106	67	-	106	-
Kanamycin	67	106	67	-	106	-
Neomycin	132	228	67	65	106	122
Sulphafurazole	132	228	67	65	106	122
Ampicillin	132	228	67	65	106	122
Colomycin	132	228	67	65	106	122
Tetracycline	132	228	67	65	106	122
Nalidixic acid	132	228	67	65	106	122

TABLE 52

NUMBER OF SHIGELLA STRAINS RESISTANT TO SPECIFIC ANTIMICROBIAL DRUGS

	Flexner		Sonne		Total	
	Numbers	Percentages	Numbers	Percentages	Numbers	Percentages
Total strains tested	132		228		360	
Neomycin	24	18.2	18	7.9	42	11.7
Ampicillin	24	18.2	81	35.5	105	29.2
Tetracycline	36	27.3	79	34.6	115	31.9
Sulphafurazole	122	92.4	213	93.4	335	93.1
Colomycin	-	-	1	0.4	1	0.3
Nalidixic acid	-	-	-	-	-	-
Total strains tested	67		106		173	
Cephaloridine	9	13.4	40	37.7	49	28.3
Kanamycin	9	13.4	11	10.4	20	11.6
Total strains tested	65		122		187	
Chloramphenicol	9	13.8	2	1.6	11	5.9
Polymyxin B	2	3.1	3	2.5	5	2.7
Streptomycin	16	24.6	87	71.3	103	55.1
Paromomycin	18	27.7	7	5.7	25	13.4

TABLE 53

VARIATIONS IN ANTIMICROBIAL DRUG RESISTANCE IN BELVIDERE AND RUCHILL

	Belvidere		Ruchill	
	Numbers	Concentration of drugs per ml.	Numbers	Concentration of drugs per ml.
Total strains tested	173		187	
Numbers resistant to drugs				
Neomycin	21 (12.1%)	10 mcg	21 (11.2%)	10 mcg
Ampicillin	53 (30.6%)	25 "	52 (27.8%)	10 "
Tetracycline	30 (17.3%)	50 "	85 (45.5%)	25 "
Sulphafurazole	164 (94.8%)	500 "	171 (91.4%)	100 "
Colomycin	-	200 "	1 (0.5%)	200 "
Nalidixic acid	-	30 "	-	30 "
Total strains tested	173		-	
Numbers resistant to drugs				
Cephaloridine	49 (28.3%)	25 mcg	-	
Kanamycin	20 (11.6%)	30 "	-	
Total strains tested	-		187	
Numbers resistant to drugs				
Chloramphenicol	-		11 (5.9%)	10 mcg
Polymyxin B	-		5 (2.7%)	300 units
Streptomycin	-		103 (55.1%)	10 mcg
Paromomycin	-		25 (13.4%)	10 mcg

TABLE 54

RESISTANCE OF (a) DIFFERENT SEROLOGICAL TYPES OF SH. FLEXNERI AND (b) SHIGELLA STRAINS ISOLATED FROM PATIENTS WITH PREVIOUS HOSPITALISATION

Types	Sh. flexneri 2 (2)	2a (4)	3a (75)	6 (1)	X (50)	Patients with previous hospitalisation Flexner	Sonne
Total strains tested (132)						11	20
Numbers resistant to drugs:							
Neomycin	–	–	8	–	16	2 (18.2%)	–
Ampicillin	–	–	9	–	15	2 (18.2%)	6 (30%)
Tetracycline	–	–	17	1	18	3 (27.3%)	7 (35%)
Sulphafurazole	2	2	73	1	44	10 (91%)	17 (85%)
Colomycin	–	–	–	–	2	–	–
Nalidixic acid	–	–	–	–	–	–	–
Total strains tested (67)							
Numbers resistant to drugs:							
Cephaloridine	–	–	4	–	5	1 (9.1%)	4 (20%)
Kanamycin	–	–	4	–	3	1 (9.1%)	–
Total strains tested (65)							
Numbers resistant to drugs:							
Chloramphenicol	–	–	–	–	9	–	–
Polymyxin B	–	–	–	–	2	–	–
Streptomycin	–	1	4	–	11	–	6 (30%)
Paromomycin	–	–	4	–	14	1 (9.1%)	–

TABLE 55

SHIGELLA STRAINS WITH MULTIPLE RESISTANCE (FLEXNER)

	No. resistant to each drug	Number of drugs to which multiple resistance is shown									
		0	1	2	3	4	5	6	7	8	
Number in each group	-	5	79	21	5	3	5	3	10	1	132
Neomycin	24	–	-	2	-	3	5	3	10	1	
Ampicillin	24	–	-	-	3	2	5	3	10	1	
Tetracycline	36	–	-	15	5	1	1	3	10	1	
Sulphafurazole	122	-	77	18	5	3	5	3	10	1	
Colomycin	-	-	-	-	-	-	-	-	-	-	
Nalidixic acid	-	-	-	-	-	-	-	-	-	-	
Celphaloridine	9	–	-	1	-	-	4	2	2	-	
Kanamycin	9	–	-	-	-	-	4	3	2	-	
Chloramphenicol	9	–	-	-	-	-	-	-	8	1	
Polymyxin B	2	–	-	1	-	-	-	-	-	1	
Streptomycin	16	–	2	2	2	1	-	-	8	1	
Paromomycin	18	–	-	3	-	2	1	1	10	1	

TABLE 56

SHIGELLA STRAINS WITH MULTIPLE RESISTANCE (SONNE)

	Total No. resistant to each drug	Number of drugs to which multiple resistance is shown									
		0	1	2	3	4	5	6	7	8	
Number in each group	-	3	65	51	80	15	10	3	1	-	228
Neomycin	18	-	-	-	-	5	9	3	1	-	
Ampicillin	81	-	-	14	42	11	10	3	1	-	
Tetracycline	79	-	5	12	46	11	2	2	1	-	
Sulphafurazole	213	-	60	45	79	15	10	3	1	-	
Colomycin	1	-	-	-	1	-	-	-	-	-	
Nalidixic acid	-	-	-	-	-	-	-	-	-	-	
Cephaloridine	40	-	-	-	25	6	8	1	-	-	
Kanamycin	11	-	-	-	-	2	8	1	-	-	
Chloramphenicol	2	-	-	-	-	-	1	1	-	-	
Polymyxin B	3	-	-	1	1	-	-	-	1	-	
Streptomycin	87	-	-	30	46	7	1	2	1	-	
Paromomycin	7	-	-	-	-	3	1	2	1	-	

TABLE 57

MULTIPLE RESISTANCE OF SHIGELLA STRAINS ISOLATED FROM PATIENTS WITH PREVIOUS HOSPITALISATION

	Total No. of drugs to which strains are resistant									
	0	1	2	3	4	5	6	7	8	Total
Flexner	-	6	3	1	-	1	-	-	-	11
Neomycin	-	-	1	-	-	1	-	-	-	
Ampicillin	-	-	-	1	-	1	-	-	-	
Tetracycline	-	-	2	1	-	-	-	-	-	
Sulphafurazole	-	6	2	1	-	1	-	-	-	
Colomycin	-	-	-	-	-	-	-	-	-	
Nalidixic acid	-	-	-	-	-	-	-	-	-	
Cephaloridine	-	-	-	-	-	1	-	-	-	
Kanamycin	-	-	-	-	-	1	-	-	-	
Chloramphenicol	-	-	-	-	-	-	-	-	-	
Polymyxin B	-	-	-	-	-	-	-	-	-	
Streptomycin	-	-	1	-	-	-	-	-	-	
Sonne	-	8	5	6	1	-	-	-	-	20
Neomycin	-	-	-	-	-	-	-	-	-	
Ampicillin	-	-	1	4	1	-	-	-	-	
Tetracycline	-	2	2	2	1	-	-	-	-	
Sulphafurazole	-	6	4	6	1	-	-	-	-	
Colomycin	-	-	-	-	-	-	-	-	-	
Nalidixic acid	-	-	-	-	-	-	-	-	-	
Cephaloridine	-	-	-	3	1	-	-	-	-	
Kanamycin	-	-	-	-	-	-	-	-	-	
Chloramphenicol	-	-	-	-	-	-	-	-	-	
Polymyxin B	-	-	-	-	-	-	-	-	-	
Streptomycin	-	-	3	3	-	-	-	-	-	
Paromomycin	-	-	-	-	-	-	-	-	-	

TABLE 58

MULTIPLE RESISTANCE IN RELATION TO AGE OF PATIENT

Age Groups	No. of drugs to which strains are resistant									Total
	0	1	2	3	4	5	6	7	8	
Flexner										
-1	1	9	2	2	-	1	1	1	-	17
1-	1	12	4	2	1	2	0	3	-	25
2-	-	18	3	-	1	2	-	1	-	25
3-	-	8	2	1	-	-	-	1	-	12
4-	1	8	1	-	-	-	-	-	1	11
5-	1	3	2	-	-	-	-	1	-	7
6-	-	6	1	-	-	-	-	-	-	7
7-	1	2	1	-	-	-	-	1	-	5
8-	-	1	-	-	-	-	-	-	-	1
9-	-	2	-	-	-	-	-	-	-	2
10-14	-	1	-	-	1	-	1	-	-	3
15+	-	9	5	-	-	-	1	2	-	17
Sonne										
-1	-	12	8	11	6	2	-	1	-	40
1-	1	9	5	17	2	3	2	-	-	39
2-	1	9	7	11	1	1	1	-	-	31
3-	-	6	7	7	1	1	-	-	-	22
4-	1	1	1	9	-	-	-	-	-	12
5-	-	6	3	4	1	1	-	-	-	15
6-	-	3	4	4	-	1	-	-	-	12
7-	-	-	2	1	1	-	-	-	-	4
8-	-	2	2	-	1	-	-	-	-	5
9-	-	2	1	2	-	-	-	-	-	5
10-14	-	3	6	8	-	-	-	-	-	17
15+	-	12	5	6	2	1	-	-	-	26

TABLE 59

SHIGELLA STRAINS EXHIBITING CROSS-RESISTANCE

	Belvidere					Ruchill			
	Shigella types	Total strains tested	Nos. resis-tant	Nos.for cross resis-tance	% with cross resis-tance	Total strains tested	Nos. resis-tant	Nos.for cross resis-tance	% with cross resis-tance
Neomycin	Flexner	67	9	9		65	15	15	
	Sonne	106	12	12		122	6	6	
	Total	173	21	21		187	21	21	
Paromomycin	Flexner	-	-	-		65	18	14	
	Sonne	-	-	-		122	7	6	
	Total	-	-	-		187	25	20	95.2
Kanamycin	Flexner	67	9	9		-	-	-	
	Sonne	106	11	11		-	-	-	
	Total	173	20	20	95.2	-	-	-	
Neomycin	Flexner	-	-	-		65	15	15	
	Sonne	-	-	-		122	6	6	
	Total	-	-	-		187	21	21	
Strepto-mycin	Flexner	-	-	-		65	16	10	
	Sonne	-	-	-		122	87	6	
	Total	-	-	-		187	103	16	76.2
Ampicillin	Flexner	67	9	9		-	-	-	
	Sonne	106	44	44		-	-	-	
	Total	173	53	53		-	-	-	
Cephalori-dine	Flexner	67	9	8		-	-	-	
	Sonne	106	40	38		-	-	-	
	Total	173	49	46	86.8	-	-	-	

STATISTICAL METHODS EMPLOYED IN THE THESIS

Example 1. Location of water closet in house

	Flexner	Sonne	Total
Houses with an outside water closet	70(53.0%) (a)	75(32.9%) (b)	145 (a+b)
Houses with an inside water closet	62(47.0%) (c)	153(67.1%) (d)	215 (c+d)
TOTAL	132 (a + c)	228 (b + d)	360 (a+b+c+d) = N)

The analysis of the above 2 x 2 table was carried out using χ^2 with Yates' continuity correction. The formula used is

$$\frac{N\left(\left|ad - bc\right| - \frac{1}{2}N\right)^2}{(a+b)(c+d)(a+c)(b+d)}, \text{ which in this example}$$

$$= \frac{360\left(\left|70 \times 153 - 75 \times 62\right| - \frac{1}{2} \times 360\right)^2}{145 \times 215 \times 132 \times 228} = 13.27$$

This figure is referred to a χ^2 distribution with one degree of freedom. [The approximation to χ^2 is reasonable since all the expected values, E, are greater than 5 (smallest $E = \frac{132}{360} \times 145 > 5$)]

13.27 is greater than 10.83, the 0.1% point of χ^2. Among patients suffering from flexner dysentery the percentage who resided in houses with an outside water closet is significantly different from that among sonne patients ($p < 0.001$).

Example 2. Shigella strains resistant to Streptomycin

	Flexner	Sonne	Total
Number of strains resistant to Streptomycin	16(24.6%) (a)	87(71.3%) (b)	103 (a + b)
Number of strains sensitive to Streptomycin	49(75.4%) (c)	35(28.7%) (d)	84 (c + d)
TOTAL	65 (a + c)	122 (b + d)	187 (a+b+c+d = N)

Using Yates' continuity correction $\chi^2 = 35.51$, d.f. = 1, $p \ll 0.001$.

The percentage who had resistant Shigella strains among those with sonne dysentery (71.3%) is significantly different from that among those with flexner dysentery (24.6%) ($p \ll 0.001$).

QUESTIONNAIRE - FLEXNER DYSENTERY SURVEY

I. BASIC DETAILS

(Please write the answers in this section. Do not fill in boxes.)

Date of Interview: _____

Name of Interviewer: _____

	1 2 3 4	
Case No.		
Shigella flexneri, serological type		5-6
Shigella sonnei, colicine type		7-8
Hospital 1 = Belvidere 2 = Ruchill		9

1. Surname: (Block letters) _____

2. Forenames: _____

3. Address: (including postal area) _____ [ ][ ] 10-11

_____

4. Occupation: (if an adult, or father's occupation in case of a child, or husband's occupation in case of a housewife. If unemployed or retired, state.)

_____ [ ] 12

Name of family doctor: _____ Address: _____

_____

(In the remainder of the form, except where otherwise stated, record the answers by entering the appropriate number in each box.)

5. Date of birth, e.g. 6th Feb. 1968 = 06 02 68 DAY [ ][ ] MONTH [ ][ ] YEAR [ ][ ] 17-18

6. Sex: 1 = Male 2 = Female [ ] 19

7. Marital Status: 1 = Single 2 = Married 3 = Widowed
4 = Other 5 = Not applicable (if under 15 years) [ ] 20

8. Nationality:

Father's nationality in case of a child.
Husband's nationality in case of a housewife.

1 = Scottish 2 = English or Welsh 3 = Irish

4 = West Indian 5 = Indian or Pakistani [ ] 21

6 = African 7 = Other X = Not known

II. HOUSING CIRCUMSTANCES

9. Type of house:
(Record the appropriate number in the box for the type of house the patient was living in when he/she had dysentery.)

1. Tenement, external water closet. 2. Tenement, internal water closet.
3. Flatted cottage or terrace house.
4. Semi-detached villa or detached villa.
5. Multi-storey flat. 6. Institution.
7. Any other housing, e.g. caravan, model lodging house. [ ] 22

10. Is the house owned by:-

1 = Corporation 2 = Private landlord
3 = Self 4 = Other organisation ? [ ] 23

11. Number of rooms in the house (excluding bathroom but including kitchen) e.g., 6 rooms = 06 [ ][ ] 24-25

12. Number of adults, i.e. persons 15 years and over, living in the house [ ][ ] 26-27

13. Number of children, i.e. persons under 15 years, living in the house [ ][ ] 28-29

14. Is there an inside W.C. in the house? 0 = No. 1 = Yes [ ] 30

15. If no, is W.C. on stairs = 2, or in the backcourt = 3 ? [ ]

16. Number of W.C.s in the house available for use. [ ] 31

17. Number of families using W.C.s. [ ] 32

18. Number of adults, i.e. persons 15 years and over, using W.C.s.
(If approximate number, state) [ ][ ] 33-34

19. Number of children, i.e. persons under 15 years, using W.C.s.
(If approximate number, state) If not known, insert X. [ ][ ] 35-36

20. Is there a washhand basin situated in the same room as the W.C.?
0 = No 1 = Yes. [ ] 37

21. Is there hot and cold water system in the house?
0 = No 1 = Yes. [ ] 38

22. Is there a fixed bath or shower in the house?
0 = No 1 = Yes. [ ] 39

C H I L D R E N

(This section is only to be filled in when the patient is a child, i.e. a person under 15 years)

23. Give in order of birth from the oldest downwards, the names, ages and nurseries or schools attended, of all the children in your house. Insert in the appropriate column whether or not the child had suffered from diarrhoea within the past 3 months. 0 = No 1 = Yes X = Not known. Mark patient by asterisk (*) after name.

Names	Age in Years	Nurseries or Schools	Diarrhoea 0, 1 or X
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

Age Groups	Diarrhoea present	Total in age group	
Under 1yr			40-41
1 -			42-43
2 -			44-45
5 -			46-47
10 - 15			48-49

	D	T	
School			50-51
Nursery			52-53
Not in school or nursery			54-55

Number of children with diarrhoea: [ ] 56

24. Did anyone in the school have diarrhoea at the same time as the patient? 0 = No 1 = Yes X = Not known. [ ] 57

25. If yes, was the occurrence of that diarrhoea

1 = immediately before your child had it
2 = immediately after your child had it
X = Not known. [ ] 58

26. Is the child's mother working?
0 = No 1 = Part-time 2 = Full-time. [ ] 59

CASE AND CONTACTS

Past History

27. Have you (adult or child) had a previous attack of dysentery?
O = No 1 = Yes X = Not known. [ ] 60

28. If yes, how many times. (Insert X if not known). [ ] 61

29. If yes, were you (adult or child) admitted to a hospital during any of the attacks of dysentery?
O = No 1 = Once 2 = Twice 3 = Thrice 4 = Four times or more
X = Not known. [ ] 62

Present History

30. Date of admission to hospital: _____

Approximate date of onset of symptoms: _____

Interval in days [ ][ ] 63-64

31. Date of discharge: _____

Length of stay in hospital in days [ ][ ] 65-66

32. Probable reason for hospitalisation:

1. Patient severely ill.
2. Danger of infecting others at home.
3. Housing conditions.
4. Parents or guardian working full-time.
5. Presence of food handlers in the house.
6. Incidental isolation of Shigella while in hospital.from some other illness.
7. Hospital or institutional transfer.
8. Any other reasons.
X. Not known. [ ] 67

33. Were you (adult or child) in contact with anyone suffering from diarrhoea in the fortnight prior to the time you had your attack?
O = No 1 = Yes X = Not known [ ] 68

34. If yes, specify was contact:
1. Living in your house.
2. Living outwith your house, but in Glasgow.
3. Living outside Glasgow.
X. Not known. [ ] 69

35. If yes, specify was contact:

1. Pre-school child 2. School child 3. Adult
4. 1 and 2 5. 2 and 3 6. 1 and 3
X. Not known. [ ] 70

36. During the week before the diarrhoea, was any article of food taken that you considered might have caused the attack?
O = No 1 = Yes X = Not known. [ ] 71

37. If yes, suspected article of food:- _____

Place where eaten: _____

Time: _____

38. During the week before the diarrhoea, have you (adult or child) been away from Glasgow for one night or more?
O = No 1 = Yes X = Not known. [ ] 72

39. If yes, specify:
1 = elsewhere in Scotland 2 = elsewhere in Britain
3 = abroad [ ] 73

40. Do you know the cause or the source of your diarrhoea?
O = No 1 = Yes X = Not known. [ ] 74

41. If yes, give details.

42. If employed, are you involved in food handling? O = No 1 = Yes [ ] 75

43. If yes, give details of employment as food handler.

44. Which do you consider most important in the prevention of a further spread of dysentery in your family?

1. Taking a well balanced diet.
2. Taking vitamins.
3. Living in a good house with a bathroom, washhand basin and internal W.C.
4. Washing of hands after using the W.C.
5. Any other factors, specify:-
6. No idea. [ ] 76

45. To which chemotherapeutic agents is the organism resistant? (Please ring).

1. Chloramphenicol. 2. Neomycin. 3. Nitrofurantoin.
4. Polymyxin B. 5. Streptomycin. 6. Sulphafurazole.
7. Ampicillin. 8. Colomycin. 9. Paromomycin. [ ] 77

10. Tetracycline. 11. Nalidixic acid.
12. Cephaloridine. 13. Kanamycin. [ ] 78

Total number of agents to which organism is resistant [ ] 79