The welfare of farm animals used for teaching purposes

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Abstract

The use of farm animals in teaching veterinary undergraduates and graduates to achieve their objectives, such as Day One competencies or diplomate status, may have a negative impact on the welfare of the animals used. There is limited published evidence reporting the impact of teaching on animal welfare and very few guidelines from accrediting bodies to help inform how animals should be used for teaching.

The first part of this study used a retrospective analysis of cases referred to the Veterinary Teaching Hospital (VTH) at the University of Glasgow (UOG) between 2013 and 2022 with the aim of describing the cases referred, and their suitability for teaching. In addition, logistic regression analysis investigated the factors that influenced animals staying less than 48 hours, where the hypothesis was animals with a short duration stay may have less optimal welfare. The second part of the study investigated the effects on sheep of being used for teaching clinical examination classes over a five-week period. Behaviours (stress (counts) and maintenance behaviour (scanned)) were observed before, during and after teaching from video recordings of the classes and factors that might influence these behaviours were investigated.

Between 2013 and 2022, the VTH received 1206 bovine cases and 703 ovine cases, ranging in age from 2 weeks to >10 years, all with various diseases within most organ systems (the most common postmortem diagnosis category being multiple systems involved (19%) and respiratory (20%) in bovine and ovine respectively). After exclusion due to missing data, 1066 bovine cases and 539 ovine cases were included in the logistic regression to investigate the possible factors on length of stay of less than 48 hours. For both species, arriving on a Tuesday increased the odds of an animal staying less than 48 hours when compared to a Monday [bovine (OR 2.61, CI 1.41-5.06), ovine (OR 2.69, CI 1.22-6.27). Additionally, for bovines, this effect was also observed on Wednesday and Thursday [Wednesday (OR 2.37, CI 1.30-4.54), Thursday (OR 1.94, CI 1.06-3.75)]. For bovines, cases in all age groups > 2 years old (compared to the age group <1year old) [2-4 year (OR 2.33, CI 1.59-3.42), 4-6 year (OR 1.77, CI 1.13-2.77), >6 year (OR 2.33, CI 1.50-3.62) and cases within the kidney, bladder and urinary tract disease category (compared to cases within the digestive category) had higher odds to stay less than 48 hours (OR 4.86, CI 1.43-18.25). For ovines other factors increasing the odds of staying < 48hours were male animals (OR 2.29, CI 1.19-4.38) and animals with unknown sex (OR 2.17, CI 1.21-3.88) (compared to females) and one individual clinician (OR 3.71, CI 1.09-13.0). The

factor disease category 'diagnosis not reached' (compared to respiratory) was associated with decreased the odds of staying < 48 hours were (OR 0.14, CI 0.03-0.46). Interestingly, for both species, neither transport distance nor travelling time were associated with an effect on duration of stay.

The second part of the study showed that individual differences between sheep were observed both in the number of stress responses and in the type of stress response. Over the five-week teaching period, the total number of stress responses decreased each week, and, on some days, sheep spent more time lying down and eating and less time standing in the one-hour period after being used for teaching.

These results suggest that the VTH at UOG receives a considerable number of cases with potentially large teaching benefits due to the variety of diseases diagnosed at postmortem. The factors identified as influencing animals staying < 48 hours could be used to help inform what cases are suitable for admission to the clinic without compromising animal welfare, but further research would need to investigate some of these effects further. With individual variation and habituation being observed in sheep clinical exam classes, this could inform teaching practice as sheep that exhibit less stress could be selected for these classes and they could be acclimatised to the teaching activity over time to minimise the impact on animal welfare. The study also suggests a rest period after being used for teaching is required but further research is needed to establish how long the rest period needs to be and if it differs depending on the length and type of class. In addition, to assess whether the benefits to students learning outweigh the negative effects on the welfare of animals used for teaching, it is necessary to consider not only the teaching event itself, but also any factors that could affect welfare throughout the time spent within the VTH.

Table of Contents

List of Tables

List of Figures

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Authors' Declaration

I declare that this dissertation is the result of my work, except where explicit reference is made to other people's contributions. It has not been submitted for any other degree at the University of Glasgow or other institution.

Name: Sander Prins

Abbreviations

AAVMC: American Association of Veterinary Medical Colleges

APHA: Animal and Plant Health Agency

ECCVT: European Coordinating Committee on Veterinary Training

EMS: Extra Mural Studies

UOG: University Of Glasgow

PM: postmortem

QBA: Qualitative Behavioural Assessment

3Rs: Replacement, Reduction and Refinement

RCVS: Royal College of Veterinary Surgeons

SCPAHFS: Scottish Centre for Production Animal Health and Food Safety

SRUC: Scotland's Rural College

VTH : Veterinary Teaching Hospital

Chapter 1 Introduction

1.1 General introduction

To train veterinary students, both undergraduates and postgraduates, for their goals, e.g. the Day One competencies (ECCVT, 2019; RCVS, 2021) for undergraduates, or diploma status for postgraduates, farm animals are sometimes used in teaching events. These teaching events could focus on animal handling, clinical examination in a particular species, or disease management. To gain clinical experience appropriate to all stages of a veterinary curriculum, veterinary schools often have a Veterinary Teaching Hospital (VTH) where they use the referred farm animal cases as models in the courses (Hubbell, 2008). The impact on animal welfare of the use of animals in veterinary teaching is a topic that has not been extensively studied in recent years. The discussion on the ethical justification of the use of animals in veterinary teaching has led to the increasing use of alternatives such as models for certain procedures in teaching to avoid the negative impact on animal welfare during live animal use (Knight and Zemanova, 2022). To assess the impact on the animal's welfare, the specific actions that could affect the welfare of the animal used, such as the transport, the stay in the VTH, the teaching event and, for example, the timing and method of euthanasia, must be recognised. Although the 3 Rs: Replacement, Reduction and Refinement (Russell WMS & Burch RL, 1959) can be used to reduce the number of animals used for veterinary teaching, it can sometimes be difficult to apply these guidelines as they were created for animals in laboratory conditions for experimental purposes and are not directly transferable to the use of animals in veterinary medicine when used for teaching knowledge and skills (Martinsen and Jukes, 2005). Because not all clinical skills and experiences can be obtained using models, if an environment with a living animal is required, the use of some animals for teaching seems unavoidable. It is therefore important to have a discussion and review of the ethics and welfare of animals used for teaching which is regularly revised. This chapter will define animal welfare, review the existing literature around the impact on the welfare and stress response of farm animals used for teaching and investigate methods to measure animal welfare. In addition, an introduction of the process of the use of farm animals within the VTH at the University of Glasgow, the Scottish Centre for Production Animal Health and Food Safety (SCPAHFS) will be given.

1.2 Defining animal welfare

The definition of animal welfare has evolved over the years along with scientific research in this area which continues to this day (Fraser, 2008; Reimert et al., 2023). The realisation that animals are sentient beings was written down by Bentham in 1823: "The question is not whether animals can think or speak, but whether they can suffer". This marked a change to the perspective of Descartes and Kand, for example, that animals are not sentient (Duncan, 2006). Although the realisation that animals have senses, emotions and consciousness was written down as early as 1839, this was not directly translated into the formalisation of animal welfare science (Duncan, 2006). The publication of Animal Machines by Ruth Harrison in 1964 and the impact of the book on public opinion led to the Brambell Committee being set up to investigate the welfare of animals, particularly farm animals, and to establish that 'welfare is a broad concept encompassing both the physical and mental well-being of the animal'. After the introduction of the Five Freedoms, animal welfare became more a field of scientific research (Brambell Committee, 1965).

Although the mental welfare of the animal was recognised, the focus and understanding of animal welfare was on the avoidance of suffering/stress in the Five Freedoms, with the assumption that the absence of this suffering/pain was indicative of positive animal welfare (Duncan, 2006; Reimert et al., 2023). The focus on stress as an indicator of negative welfare in research has led to the investigation of stress indicators in the form of physiological measures, such as studies of cortisol concentration and heart rate (Dawkins, 2003), also in addition to behavioural indicators, such as the fight and flight response to certain stressors (Roelofs, 2017). Although an increase in these measures may indicate that the animal is experiencing stress, increases can also be observed during normal activities and are sometimes difficult to interpret on their own (Barnett and Hemsworth, 1990). Subsequently, several definitions of animal welfare were introduced: Broom stated in 1986 that an animal's welfare is its ability to cope with and adapt to the environment (Broom, 1986), Dawkins introduced in 2003 that an animal's welfare can be defined by answering the questions of whether the animal is physically healthy and whether it has what it wants (Dawkins, 2003). In 2007, Boissy et al. stated that "good welfare is not only the absence of negative affective states, but also the presence of positive affective states, such as pleasure' (Boissy et al., 2007). Furthermore, they stated that "the absence of signs of pleasure or positive affect is in itself an indication of negative animal welfare". Positive animal welfare focuses on animal happiness and rewarding behaviour (Webb et al., 2019; Rault et al., 2020).

The acceptance of emotions in the science of animal welfare has led to the Five Freedoms being updated (Mellor and Beausoleil, 2015), but also to new quality of life terms being introduced to describe a more comprehensive approach to animal welfare (Green and Mellor, 2011; Mellor, 2016). Although an animal may have a situation in which the physical and mental state is negative, the balance with positive indicators over time results in a balance that can be more negative or more positive depending on how many negative and positive indicators are found and the weight given to these indicators (Mellor and Beausoleil, 2015; Mattiello et al., 2019; P. Sandøe et al., 2019; Broom, 2023; Reimert et al., 2023).

1.2.1 The Five Domains instead of the Five Freedoms

The recognition that animal welfare is not just the physiological functioning of the animal, but that the affective state in relation to its physiological functioning and natural behaviour might be more reflective of welfare status. Mellor has refined the Five Freedoms into five domains and opened up multiple ways of approaching an assessment of animal welfare (Mellor, 2017): three physiological domains (internal state), one situation-related domain (behaviour, external factors) and an affective domain of experience that expresses negative or positive emotions about the other four domains (Figure 1-1).

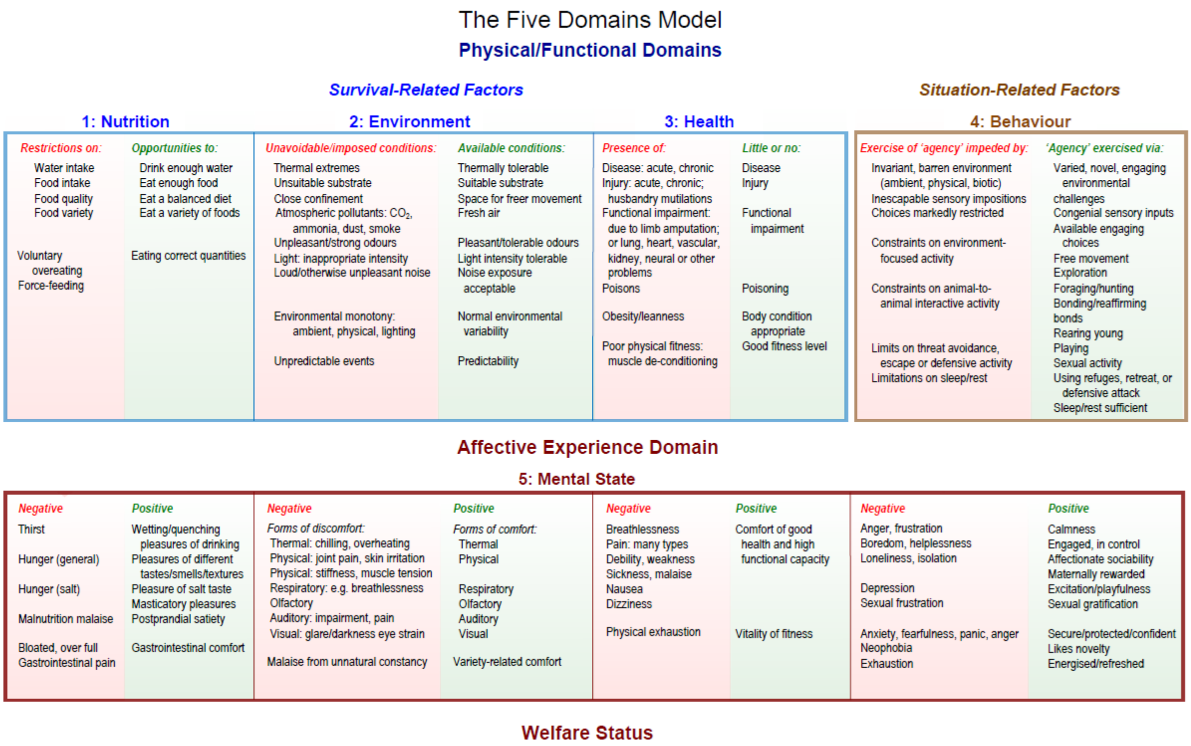

Figure 1-1 Five domains to assess the welfare status of an animal. The affective experience domain reflects on the physical/functional domain and on the situation-related factors (Mellor, 2017)

The internal states for the three domains 'nutrition', 'environment' and 'health' are understood to be genetically programmed and lead to an animal exhibiting certain behaviour to ensure its survival (Mellor, 2017). For example, if an animal experiences that it is thirsty (affective state), it will search for water (behaviour, situation related factor) as this is internally regulated by its genetics to perform a behaviour that ensures its survival. If the animal has a health problem, e.g. lameness, the associated affective state could be that it perceives pain and is therefore internally stimulated to perform a behaviour to avoid this pain by standing less and lying down more (Theurer, Amrine and White, 2013; Dittrich, Gertz and Krieter, 2019). The perception of pain in the event of illness or trauma leads to the behaviour of avoiding this pain.

Sometimes the performance of a natural behaviour depends on external factors: such as the presence of other animals of the same species (social and reproductive behaviour), but also the presence of other species (Figure 1-2) (Broom, 2023). The possibility, or impossibility of performing this behaviour can give an animal a negative affective state, e.g. frustration, or a positive affective state, e.g. pleasure (Rault, 2012a). Although behavioural responses to an affective state are genetically determined (Boissy et al., 2005; Sebastian et al., 2011), and the internal state is controlled by endocrine and nervous pathways and changes in hormone secretion (Henry JP., 1992; Dwyer and Bornett, 2004), the response can be influenced by various factors such as previous experiences (Romeyer and Bouissou, 1992; Grandin and Shivley, 2015; Bolt et al., 2017), sex (Viérin and Bouissou, 2003; Forkman et al., 2007), and age (Watts and Stookey, 2000).

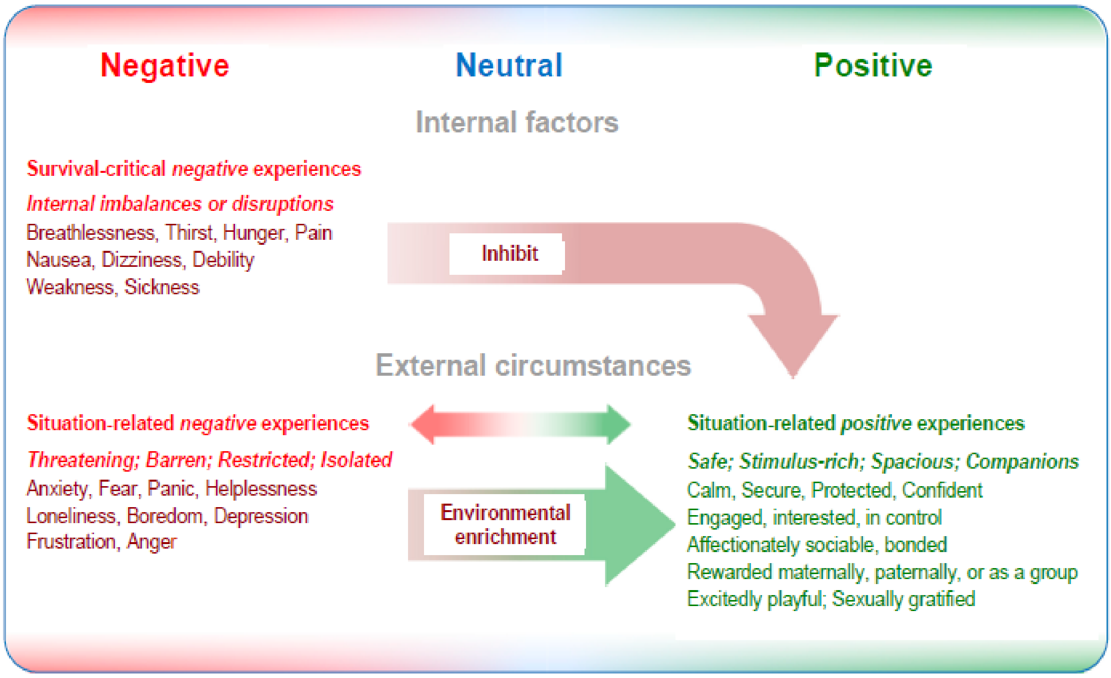

Figure 1-2. Depending on internal factors or external circumstances affective states can resolve or change into positive experiences (if started as negative experience) or negative experience (if started as positive experience) (Mellor, 2017)

1.3 Assessment of animal welfare

Since the affective state and its associated behaviour reflect internal states or external situations, the measurement of this affective state can be performed to assess a part of the welfare of the animals at that moment, which can be done, for example, with the assessment of pain of cattle and sheep (Gleerup et al., 2015; McLennan et al., 2016; Machado and da Silva, 2020) in combination with normal behaviour and social behaviour (Houpt, 2018; Williams et al., 2021). The type of behaviour that needs to be investigated depends on the specific situation and the expected affective state.

1.3.1 Behavioural assessment of animal welfare

The measurement of behaviour to assess a part of the welfare through the affective state of the animal has been done in many studies but it is important to know the context of these assessments: is the behaviour used as an single indicator representing the total quality of life;, whole animal measure, or is a combination of measures used ; such as behavioural data plus physiological data such as body condition score (Browning, 2022). Whole animal measures can be differentiated between human intuitive estimates and Qualitative Behavioural Assessment (QBA). Human intuitive estimates has been a common method using behaviour of a single indicator at a single animal taken at a single time point but relies on the assumption that an animal can weigh its positive and negative affective states (input) and therefore produces a behavioural (and physiological) output that can be used as indicator of its welfare (Browning, 2022). It is quick method and can be easy to apply and gives information of the animal on that specific time point. The disadvantages of using whole animal measures could be that these measures involving human observers with the possibility of a subjective assessment: the assessment of the behaviour is based on the intuitive judgement of the observer, that all depends on the information it has seen before the assessment (Browning, 2022). Differences between observers are not uncommon (Otten, Rousing and Forkman, 2017; Veasey, 2020) and therefore makes it a less accurate as a single method to assess welfare. Although human intuitive estimates describes the behaviour an animal performs it does not really give the context in which it does and how the animal performs the behaviour for example, the body language or the expression is not captured (Fleming, 2016).

1.3.2 Qualitative behavioural assessment

Because sometimes the interpretation of the behaviour depends on the availability of information that the observer has of the context and therefore creating a bias, the QBA is a version of the behavioural assessment that uses the behaviour, body language and the way it interacts with its environment (Wemelsfelder et al., 2001; Browning, 2022). For example instead of describing that an ewe is distressed, if separated from her lamb, QBA is describing that a ewe, if separated from her lamb, walks with her ears high up, stops frequently to look around, bleatingly loudly and all this while appearing agitated, anxious and distressed (Wemelsfelder, 2000).

1.3.3 Combination of measures to assess welfare

When multiple indicators are used to assess the welfare of the animal in multiple domains (such as health, nutrition and behaviour), it can give more detailed information (Browning, 2022). The difficulty with including multiple indicators into assessment of animal welfare is the correct weighing of these individual indicators, which could be more based on expert opinion (de Graaf et al., 2018; P Sandøe et al., 2019) than of measured effect on the animals and if all of the individual indicators are validated towards the subjective welfare (Browning, 2022).

1.4 Stress reaction of animals in various situations that could occur during teaching events

The behavioural and physiological response to a particular event that is perceived as stressful by the animal (affective state) depends on the situation. In the case of the use of an animal for teaching purposes, there are several factors that can be perceived as stressful by the animal: the approach/contact by humans, the transport, the introduction to a new environment and possibly the isolation of the animal from the other animals in the herd/flock and the disease itself.

1.4.1 Stress response in the animal

Animals react to a stressor with behavioural and physiological responses that are related to their affective state (Deiss et al., 2009). The first direct visible response to a stressor is a behavioural response, caused by a physiological response of activation of the central nervous system as well as the endocrine and immune systems (Moberg, 2000). Activation of the autonomous nervous system and the hypothalamic-pituitary-adrenal axis links the central nervous system and the immune system through the release of neuropeptides and neurohormones such as adrenaline, noradrenaline and cortisol, which are responsible for changes in cellular and humoral immune responses (Borghetti et al., 2009; Düpjan and Dawkins, 2022). Although adrenaline and noradrenaline are released almost instantaneously, increases of cortisol levels in blood do not occur immediately. For example, peak blood cortisol levels do not reach their peak until ten to twenty minutes after the onset of the stressor (Lay Jr. et al., 1992). Elevated cortisol levels have an impact on the humoral immune system (Dhabhar, 2009). Cytokines can give an indication of prolonged stress in animals and humans (Black, 2002).

1.4.2 Stress towards humans

An animal's perception of stress when approached by humans depends on previous interactions it has had with humans (Beaujouan, Cromer and Boivin, 2021). Although for most farm animals the natural response to humans will be a fearful one (Grandin and Shivley, 2015), previous positive human interactions can reduce flight distance (Price and Tennessen, 1981). If the previous interactions involved positive rewarding events (such as feeding, petting), then this will result in an animal approaching the human (Hargreaves and Hutson, 1990; Probst et al., 2013; Munoz et al., 2019) whereas negative interactions, especially if unpredictable, will trigger fear responses towards the human, such as flight (Fernandes et al., 2021). In 2015, Coulon et al. found that human petting of lambs resulted in reduced heart rate, lower ear drooping positions and less movement upon contact with humans compared to the presence of a motionless human (Coulon et al., 2015). The age of first contact with the human affects the response to the human, along with the presence of the mother in the case of a young animal (Nowak and Boivin, 2015): If the mother is anxious, this has a negative effect on the interaction between human and young animal, whereas the interaction between human and animal is more positive if the animal is alone or with a calm mother (Henry et al., 2005). In addition to the animal's previous experiences, a genetic component also has an effect on the animal's anxiety, but also on whether it is able to form a human-animal bond (Haskell, Simm and Turner, 2014).

1.4.3 Stress towards new environment

Few studies in farm animals have investigated the effects of a new environment on the animal. In 2016, Razzuoli found that introducing young bulls to a new environment causes an increase in serum cytokine levels, indicating the perception of stress. They also found a difference in the high serum levels of these cytokines between an introduction to a new environment in January and an introduction to a new environment in July, suggesting a temperature effect, but no behavioural assessment was performed in this study (Razzuoli et al., 2016). In 2023, Moriconi found in a study of bulls introduced to a new environment that this led to an increase in cytokines. These cytokines were linked to the mediation of stress responses but again, no behavioural assessment was conducted in this study (Moriconi et al., 2023).

1.4.4 Stress towards isolation of the herd/flock

Cattle and sheep are group animals and herd or flock isolation can be perceived as stressful, affecting behaviours such as grazing activity (Michelena et al., 2004) and lying behaviour (Richmond et al., 2017), but also leading to increased heart rate (Forkman et al., 2007). The effect of social buffering by group members on the fear response was investigated by Gonzales et al. 2013. In this study, they compared the fear response to a novel object between sheep in isolation and in a group. They found that the fear response was lower when they were in a group (González et al., 2013). In 2000, Grignard et al. found when testing docility of calves to humans, that calves that could see peers reacted less anxiously to restraint than calves that could not see their peers. Docility towards humans did not change as a result (Grignard et al., 2000). Behavioural, cardiac and cortisol responses to isolation were also observed by Boissy et al. in 1997. In this study, they investigated the effect of short-term isolation and reunion with familiar and unfamiliar heifers. They observed an increase in vocalisation at the time of isolation, together with an increase in heart rate and plasma cortisol levels in all heifers. (Boissy et al., 1997).

1.4.5 Stress towards transport/constraint

The transport of the animal can be divided into several factors, such as handling and transport in a new environment, unfamiliar grouping, cold/hot environment, road conditions (Bhatt et al., 2021). The stress responses, both physiological and behavioural, to handling and transport depend on the animal's previous experience of these events and to the type of handling; if the handling is rough a larger stress response can be expected (Broom, 2005). The response to handling depends on many factors, as already described in the section on stress towards humans. In relation to transport, stress in cattle in a crush chute was studied by Grandin et al. 1997 by observing plasma cortisol levels and behavioural responses such as agitation and differences between individuals and animals reared in different environments (extensive vs. intensive) (Grandin, 1997). During transport, an increase in heart rate and cortisol is usually observed (Broom, 2003). Behavioural changes such as agitation, increased urination and defecation are generally more likely to be observed at the beginning of transport (Jurkovich, Hejel and Kovács, 2024).

1.5 Methods to assess the stress response of animals

To assess a stress response, ideally both the behavioural and physiological components should be measured (Grandin, 1997). Measurement of the physiological component such as heart rate or heart rate variability has been carried out in several studies and can give a good indication of short-term stress (Palestrini et al., 1998; Sutherland et al., 2019; Kitajima et al., 2021; Wascher, 2021). To measure heart rate or heart rate variability, most studies used a heart rate monitor attached to the animal with a strap around the chest. Although heart rate variability can be used as an indicator of the autonomic nervous system and more specific as a balance between the sympatic and parasympatic nervous system.It requires an ECG monitoring system attached to the animal that could itself create stress to the animal. Also for a reliable heart rate variability, animals should be measured for at least 24 hours which may not be practical (Manzo, 2009).
The use of cortisol as an indicator of stress has been demonstrated in several studies and can be measured in different ways: in blood plasma, saliva, faeces and hair (Möstl and Palme, 2002; Tamminen et al., 2021; Botía et al., 2023). In addition to the disruptive effect of handling to obtain the cortisol indicator (e.g. blood sampling and saliva sampling) (Möstl and Palme, 2002;

Caroprese et al., 2010), it is usually only detectable after a certain delay; the peak values of cortisol in plasma are ten to twenty minutes after the onset of the stressor (Lay Jr. et al., 1992), while cortisol in faeces may only be detectable after ten to twelve hours (Möstl and Palme, 2002). In addition, the relatively short half-life in blood (less than two hours in cattle) (Botía et al., 2023), means timing of sampling is important Disadvantages of using cortisol as an indicator can be that is difficult to quantify its value when repetitive actions are performed on the same animal in a short period; when different students are using the same sheep after each other it might be difficult to differentiate between the attempts, partly because the halflife time of cortisol can be longer than the different attempts (Bornez, 2009).

Behavioural assessments of animals to evaluate stress have been conducted in several studies, mostly in combination with other biomarkers (Palestrini et al., 1998; Caroprese et al., 2010; Hemsworth et al., 2019). Behavioural observations require the animal to be within sight of the observer (either in person or using video footage). To create as complete a record of behaviour as possible, continuous observations of multiple behaviours are required, but this is time-consuming and labour-intensive (Altmann, 1974; Lehner, 1992; Bateson and Martin, 2021). Disadvantages of behavioural assessment could be that the presence of humans could interfere with the display of a particular behaviour (Broom, 2023) or that a particular behaviour is interpreted as stressful behaviour by the observer when in fact the animals are actually displaying normal behaviour (Watters, Krebs and Eschmann, 2021).

1.6 The welfare of animals used in teaching veterinary medicine

The impact on animal welfare of the use of animals in teaching has been investigated in a limited number of published studies across different animal species. The focus in published studies was on the negative impact on animal welfare, mainly by investigating the stress response of the animals used during the veterinary course. In 2017, Van Vollenhoven investigated the effect of rectal palpation of horses by students on the stress response of these horses by measuring the heart rate variability and heart rate of the horses as an indicator of stress before, during and after rectal palpation, depending on the age of the animal and the animal's previous experience with this procedure. They found that there were no differences in heart rate variability and heart rate responses between animals with different ages or animals that had more experience with this procedure compared to animals that were less experienced. It confirmed that the animals showed a stress response within the first five minutes after rectal palpation and that the stress response can be increased by long confinement alone, even if no veterinary procedure is performed

Guinnefollau et al. investigated in 2021 the stress responses of teaching horses during three types of routine veterinary practical teaching classes (animal handling, rectal examination and mare reproductive examination) under field conditions by measuring heart rate and behavioural parameters. It was found that heart rate and behavioural responses to stress were limited when the three types of veterinary teaching classes were performed by students, suggesting that habituation to these procedures may have already taken place as they had been used for teaching classes before. Giese et al. in 2018 investigated the effect of different types of student preparation for rectal palpation teaching on cattle by measuring plasma cortisol levels and heart rate in these cows when veterinary students performed rectal palpation. The study found that the stress response appeared to be lower in cows with students who completed simulator preparation than in students who completed theoretical preparation. A disadvantage of this study is that the animals in this study were not accustomed to the confinement required to perform transrectal palpation and this could have already induced a stress response although there is still a difference found between simulator prepared students and not simulator prepared students.

The impact on the welfare of sick animals when they are used for teaching purposes is an issue that has not been investigated and therefore leaves a gap in our knowledge of how they are used and the impact that their stay in a VTH may have on these animals when used for teaching purposes.

1.7 Legislation and guidance on the use of animals for teaching purposes.

Depending on the person or animal benefiting from the specific use of the farm animals used for teaching purposes, the matter is regulated by different laws in the UK:

As long as the clinical examinations, diagnostics and treatments carried out are for the benefit of the animal, these procedures can be carried out by students in the clinical phase of their studies as long as they are supervised by a qualified veterinary surgeon, as described in the Veterinary Surgeons Act 1966 (*Veterinary Surgeons Act 1966*, 1966). The conditions, e.g. housing requirements, that the owner should fulfil are outlined in the Animal Welfare Act 2006 (*Animal Welfare Act 2006*, 2006). From this perspective, teaching using cases referred to a VTH is covered by the Veterinary Surgeons Act, as long as the training in specific clinical examination, diagnostics and treatment is for the benefit of the individual animal.

In the United Kingdom, The Animals (Scientific Procedures) Act 1986 (The Animals (Scientific Procedures) Act 1986) as legislated by the Home Office, has provision for the protection of animals used for experimental or other scientific purpose; however, this does not specifically cover teaching. There are also very limited published guidelines from accrediting bodies such as the RCVS and the American Veterinary Medical Association (AVMA). The American Association of Veterinary Medical Colleges (AAVMC) recently produced a handbook called 'The use of animals in Veterinary Education' (AAVMC Task Force on the Use of Animals in Veterinary Education, 2024) in response to the AAVMC Guidelines for the Use of Animals in Veterinary Education (Hunt et al., 2022) but this gives very little tangible, practical advice on how long an animal can be restrained for teaching a clinical exam class or how to manage transporting sick animals to a VTH for example.

1.8 Ethics around the use of animals for teaching purposes

The use of animals for teaching purposes and the negative effects this can have on the welfare of the animals raises the question of whether these negative effects on the welfare of the animals can be justified. The argument in favour of the use of animals in teaching can be approached from different angles, such as utilitarianism and deontology (Mullan and Main, 2001; Kipperman, 2022). Utilitarianism could be summarised as 'the greatest good for the greatest number'. If a situation does not lead to a good outcome, the harm should be minimised. To judge whether a situation is justifiable, the benefits should outweigh the costs of an action. Therefore, the expected consequences of each decision must be considered and known (Mullan and Main, 2001). The difficulties of this view lie in the weighing of costs and benefits, the prediction of the expected consequences and in the fact that it focuses less on the individual (Leuven & Višak, 2013; Mullan & Main, 2001). Deontology demands that moral decisions should be made according to certain rules. These rules should be followed regardless of the situation and in every similar situation, without considering the consequences of these decisions and without checking whether the decisions lead to the greatest overall benefit (Mullan and Main, 2001). Since this view requires that certain rules be followed regardless of the situations without allowing space for exceptions, it can be difficult to apply in practical situations. In relation the use of animals for teaching this approach could be used when designing protocols for the use of animals in specific teaching events by specifying the procedure and the steps that need to be followed to ensure animal welfare is not compromised.

Although the utilitarian approach has negative aspects and focuses less on the individual, this approach is commonly used as an argument to justify the use of animals in general, but also the use of animals in teaching. In the utilitarian perspective, the focus is on minimising the harm (physical and emotional) directly associated with the teaching event, as well as enhancing other aspects of the animal's lifetime through good husbandry (Webster, 2014). From this perspective, the use of an animal, with or without illness, for teaching purposes may be justified if the teaching event has a greater benefit than the costs (negative impact on the animal's welfare).

With regard to the use of an animal for teaching purposes, a benefit could be that by teaching veterinary students specific examinations, diagnostics and treatments on an individual animal, the harm of similar measures for the species in question or similar species in the future is minimised. The precise costs (negative impact on animal welfare) must be specified for all the different aspects of the teaching event: before, during and after the event. Before teaching could mean: transport to the VTH, the stay in the VTH. During the teaching event could mean: a clinical examination, a diagnostic test or a treatment. After the teaching event it could mean: the stay in the VTH, outcome of stay at VTH. The differences in the teaching events mean that for every teaching event, a specific justification needs to made if the benefits of the respective event outweigh the costs for the animal.

1.9 Scottish Centre for Production Animal Health and Food Safety

As a VTH the University of Glasgow, School of Biodiversity and Veterinary Medicine, Scottish Centre for Production Animal Health and Food Safety (SCPAHFS) provides, besides teaching, a clinical service for the referring veterinary practitioners and their farmer clients. Because of biosecurity reasons and food safety, SCPAHFS acts differently from other VTHs in that none of the referred cases can go back to the farm of origin or slaughterhouse after their stay in VTH, the cases can only leave SCPAHFS through a postmortem examination. The SCPAHFS is staffed by two farm animal residents and six clinicians. Residents typically work in the SCPAHFS for two weeks in a row, then have two weeks off with clinicians working a 1:6 rota. Clinicians and resident work together with the students on case management but occasionally residents and clinicians have to make decisions about cases on their own.

1.9.1 Referral of a case to SCPAHFS

Referral of a case will be performed by a local veterinarian through contact with the resident or clinician on duty at SCPHAFS. Together they will discuss the case and decide if the case is suitable to be referred; criteria that are used are if the animal is fit for transport, not only on the moment of contact but also in the near future after contact, as transport to SCPAHFS cannot always be arranged on the same day. To aid prioritisation of cases for transportation the veterinarian is asked to rank the case in terms of urgency as low, medium or high. To gather the history information from the veterinarian and later the history of the farmer, specific forms are used to structure the information gathering (Appendix 1). The history taking task will be performed by the clinician or resident on duty, or by the final year students depending on the case or farmer. Once the history has been taken the transport of the case will be arranged, aiming to be picked up within as short a time frame as possible by a driver contracted by the University of Glasgow. The driver will contact the farmer and arrange a day and time to pick up the animal. Once the driver is on the farm, he will assess if the animal is fit for transportation (Cockram, 2019) and if the animal has the legally required two ear tags, if all legal requirements are met, they will load the animal on to the trailer. Accompanying the animal are a passport (in case of a bovine case) or transport document (in case of ovine cases) together with a signed consent form by the farm (Appendix 1). The referred case is donated to the SCPAHFS by the owner and is thereafter the responsibility of SCPAHFS. As a gesture, the farmer will receive a small amount of money for the time he needs to spend referring the case.

1.9.2 Case Work up and Progression

Once the case arrives at SCPAHFS, an initial assessment of the case (performed by the clinician and/or resident plus final year students) will be performed to see if acute treatment is required, otherwise time to settle will be given to the case by placing it in a pen. After time to settle, a full clinical examination will performed by the clinician on duty and the students (Appendix 1) and afterwards together they will decide what treatment will be given and if further investigations are necessary to perform for investigation of the individual or herd/flock problem. During this period, the patient will stay in age, species, breed and size appropriate housing. Animals are examined daily and response to any treatment will be evaluated. Although the animal can only exit the SCPAHFS by postmortem examination, the time it stays in SCPAHFS can be different between cases; if the welfare of the animal is judged to be comprised or, in some cases, as part of the clinical service (for example ‘iceberg’ disease screening of representative sheep), these animals will be euthanised and send to the post-mortem facility of the University of Glasgow to get a post-mortem diagnosis and thereby finalise the diagnosis for the referring case. Ultimately the clinician and resident on duty each week decide on the end point for each case. In some cases, animals are retained by SCPAHFS for longer periods for use as long-term teaching cases; for example, cases which recover from initial clinical presentation or are very stable (See Section 1.6.2). The outcome of the case is communicated to the referring veterinarians and farmers.

1.9.3 Static animals in SCPAHFS

Although in most cases a postmortem will be performed after clinical examinations and further diagnostics and treatments have been performed, some cases will recover clinically from their disease and can remain as a static animal in SCPAHFS. It is usually these animals that are used to teach undergraduates clinical examinations or assess them on practical skills. The length of the stay within SCPAHFS of these cases depends on their character when used for teaching and if there are other cases waiting to be transformed into static animals.

1.9.4 Types of teaching events in SCPHAFS

Within SCPAHFS the use of animals for teaching events can be divided into teaching events on animals that have a clinical disease (active cases) and animal that are healthy/have a subclinical disease (the static animals). Usually, classes to teach specific assets of veterinary medicine uses animals that are healthy/have a subclinical disease, their use is according to the standard operation protocol (SOP) (Appendix 1), which describes how many times an animal can be used for teaching purposes and how to record the animal if used for teaching. For animals that have a clinical disease, student learning occurs through working up the case together with the clinicians and residents followed by additional diagnostics and treatments that need to be given if necessary. Students working in the SCPAHFS benefit from this learning environment as they have primary case responsibility for daily clinical examination, diagnostic work up and decision making for cases (under the guidance of clinicians and residents). Students learn in a VTH where there are not under time pressure which allows them the space to practice their practical and clinical reasoning skills without the scrutiny of a farmer. These cases can also be used for 'abnormal' clinical examination classes for students in the 3rd and 4th year of the five-year veterinary programme. If the animal can no longer be used for teaching purposes due to behaviour, fitness or other reasons, the animal will be euthanised and used for surgery classes or sent immediately to the PM room.

1.10 Aims of the study

There is a limited number of studies published that report the impact on the welfare of animals used for teaching both within a VTH and clinical examination classes. Giving students the opportunity to learn using live animals in an authentic farming environment is essential to them developing the day one competences required upon graduation. To investigate the impact of the use of animals in teaching events on cases referred to the SCPAHFS, the study was divided into two distinct parts, each with its own aims:

The first part of the study focused on the demographics of clinical teaching cases referred to the VTH and tried to identify factors that might influence a case remaining at SCPAHFS for less than 48 hours, with the following aims:

- To report the demographics of clinical teaching cases admitted to SCPAHFS between 2014 to 2023
- To investigate the factors that influence the duration of stay of less than 48 hours for bovine and ovine cases, specifically disease category, age, travel distance/time from the clinic, weekday of arrival, month of arrival and purpose of the farm of origin (in case of cattle) and clinician.

The second part of the study focused on a specific teaching event, a clinical exam class, and the possible effects on the animal's welfare by focusing on behavioural stress responses and maintenance behaviour before, during and after the teaching event. Therefore, the following aims were used:

- To establish levels of stress and evidence of habituation experienced by sheep during teaching.
- To investigate the differences in maintenance behavior before, during and after teaching.
- To investigate the factors that influence stress behavior.

Chapter 2

A review of the caseload of a farm animal teaching hospital: investigating how animal welfare may be impacted

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2.1 Abstract

2.1.1 Background

To train veterinary students towards their day one clinical competences, farm animals are used for teaching purposes. Farm animal cases referred to veterinary teaching hospitals (VTH) are often used for teaching purposes. As a referred clinical case, there are several potential ways that the welfare of the case may be impacted, both positively and negatively: by the disease itself, transport to the VTH and, in the hospital, by a new environment, the stockpersons, the clinicians and students during clinical management and use for teaching. This study reviews farm animal cases admitted to a VTH over a nine-year period and attempts to identify factors impacting on welfare, and particularly those influencing a duration of stay shorter than 48 hours in a teaching hospital, which may be hypothesised to equate to a poorer welfare status.

2.1.2 Methods

A retrospective study of the cases referred in the period between 2013-2022 to the Scottish Centre for Production Animal Health and Food Safety (SCPAHFS) and investigation of factors that could influence a stay shorter than 48 hours within SCPAHFS was performed based on the diagnosis given after the postmortem was performed; it could be just the postmortmem diagnosis or a combination of clinical and postmortem diagnosis in relation to the factors of year, month and weekday of arrival, sex, type of animal, distance travelled to SCPAHFS, journey time to SCPAHFS and clinician .

2.1.3 Results

Between 2013-2022, the two main species referred were bovine (n=1206) and ovine (n=703). The most common age for bovine case presentation was younger than one year (38% of cases), and aged three to four years for sheep (23% of cases). A wide variety of cases were admitted with the main disease categories diagnosed by postmortem for the bovine cases were the

category ‘multiple organs involved’ (19% of cases) followed by digestive diseases (18 % of cases). In ovine cases respiratory disease was diagnosed most (20% of cases) followed by digestive disease (13% of cases). For both bovine and ovine cases, arriving on a Tuesday was associated with higher odds to stay less than 48 hours, compared to cases that arrive on Monday (OR_{bovine} 2.61, CI 1.41-5.06; OR_{ovine} 2.69, CI 1.22-6.27). Ovine cases that arrived on a Friday had a lower odds to stay less than 48 hours, compared to cases that arrive on a Monday (OR 0.17, CI 0.03-0.74). For bovine cases, compared to the age group <1year old, cases in the age groups above 2 years old had higher odds to stay less than 48 hours (groups 2-<4 year [OR 2.33, CI 1.59-3.42], 4-<6 year [OR 1.77, CI 1.13-2.77], group >6yr [OR 2.33, CI 1.50-3.62] $p<0.05$). Cases within in the kidney bladder and urinary tract category had higher odds (OR 4.86, CI 1.43-18.25, $p<0.05$) to stay less than 48 compared to cases within the digestive category. Cases within the category diagnosis not reached, had lower odds to stay less than 48 hours (OR 0.36, CI 0.13-0.85, $p<0.05$) compared to cases within the digestive category. For ovine cases within the diagnosis not reached category, and the category ‘no information, no PM and other’ had lower odds to stay less than 48 hours (Diagnosis not reached [OR 0.14, CI 0.03-0.46], No information, no PM and other [OR 0.50, CI 0.23-1.04], $p<0.05$) compared to diseases within the respiratory category.

2.1.4 Conclusion

The diversity of teaching cases admitted should allow students to learn and benefit from farm animal aspects of veterinary medicine in these cases. A factor that influenced a case staying less than 48 hours for both species is the weekday of arrival. For bovines, cases within the kidney, bladder and urinary tract disease category have higher odds of staying less than 48 hours after arrival than cases of other disease categories. For ovine cases, certain clinicians are observed to increase the odds of staying less than 48 hours. More research is needed into the relationship between these factors and the decision to euthanise in order to better interpret them..

2.2 Introduction

To train veterinary students towards day one clinical competences (ECCVT, 2019; RCVS, 2021) many veterinary schools have their own farm teaching hospital (VTH) to give students the opportunity to gain clinical and animal handling experience on various occasions during their curriculum. This could comprise teaching animal handling, clinical examination, clinical reasoning, patient responsibility, record-keeping, medicines administration and team collaboration. Depending on the goal of the specific VTH, besides teaching, the cases that are referred may be categorised as more basic acute cases or more chronic advanced cases (Hubbell, 2008), depending on the policies the VTH has. In addition, depending on the goals and biosecurity policies of the VTH, farm animal cases may be allowed to go back to the farm of origin, or they may only leave the VTH through postmortem.

The impact of the stay in the VTH hospital on the welfare of the animal can be affected by several factors; the disease of the animal itself (Broom and Corke, 2002; Bruijnis et al., 2012; Nielsen et al., 2021; Edwardes et al., 2024)); transport to the VTH (Earley et al., 2017; Bhatt et al., 2021), the distance and time of the transport (Broom, 2005; Minka and Ayo, 2012; Alam et al., 2018), the handling for transport (Grandin, 1997; Hemsworth et al., 2011), and the temperament of the animal (Fazio et al., 2012). Introduction to a new environment, together with isolation from the herd or flock of origin could be an additional stressor for the animal (Rivalland et al., 2007; González et al., 2013b; Grandin and Shivley, 2015; Williams et al., 2021). The stress reaction towards the clinicians, stockpersons and students, when handled (this can depend on the conditions the animal was raised in, previous experiences with humans, and breed of the animal (Mateo, Estep and Mccann, 1991a; Le Neindre, Boivin and Boissy, 1996; Waiblinger, Menke and Coleman, 2002; Boivin et al., 2003; Breuer, Hemsworth and Coleman, 2003; Waiblinger et al., 2004)), In all cases, welfare may be impacted both positively and negatively.

Because of biosecurity and food safety policies, the Scottish Centre for Production Animal Health and Food Safety (SCPAHFS) has the policy that no animal will return to the farm of origin or will go slaughterhouse after the stay in SCPAHFS, and the cases can only leave SCPAHFS dead with a subsequent postmortem examination. In most cases, a case-by-case decision-making process is followed for when euthanasia occurs. The decision to euthanise an animal will be based on the clinical status of the animal and with the intention in mind to prevent further suffering of the animal (Leary and American Veterinary Medical Association, 2020). In the minority of cases, an animal may die in the hospital, in which case it also goes for postmortem examination. Because the case is used for teaching, the question could be raised if the potential negative impact of the transport and disease on the welfare of the animal is overweighing the teaching benefits, especially if a case remains for a short time within SCPAHFS.

This study aimed to document those cases admitted over a nine-year period and investigate factors affecting the length of stay at the SCPAHFS VTH and, thus, those that may have a potential impact on the welfare of the animal. The overall objective was to see if an improvement in the selection of referred cases is possible, minimising negative impacts on welfare, without losing access to valuable teaching cases. The specific aims were:

1. To report the demographics of clinical teaching cases admitted between 2013 to 2022.
2. To investigate the factors that influence the duration of stay of less than 48 hours for bovine and ovine cases, including disease category, age, travel distance/time from the clinic, weekday of arrival, month of arrival and type of animal (in case of cattle), individual or group case, sex and duty clinician.

2.3 Materials & methods

2.3.1 Study design

A retrospective review of medical records of all cases submitted to the Scottish Centre for Production Animal Health and Food Safety (SCPAHFS), during the period 2013 to 2022 was performed. The cases and clinical details were extracted from a Microsoft Excel spread sheet on which all details were recorded throughout the years. All identifiable information of the farm of origin was removed.

2.3.2 Setting and background

Clinical cases are referred to SCPAHFS at the University of Glasgow by the farmer's veterinary surgeon, after they have been examined by the veterinarian and found fit for transport. The case is discussed between the referring veterinarian with the SCPAHFS on-call veterinarian to determine whether the case is appropriate for referral.

If the case is considered appropriate to refer, an extended history of the farm, herd/flock of origin and patient is taken (from both the referring veterinary surgeon and the farmer), and the case is collected by a contracted driver trained in animal transportation. The driver will transport the case to SCPAHFS after checking at the farm that it is still fit for transport (Cockram, 2019). Farmers sign a consent form, transferring ownership of the animal to University of Glasgow and give consent for information regarding the case to be used for research purposes. Farmers are given a donation of £50 for each bovine case and £20 for each ovine case to help cover some of their costs. Cases do not return to the farm of origin, or enter the human food chain, but only leave SCPAHFS through a post-mortem examination in the post-mortem room or, in a minority of cases, become ‘static’, resident teaching cases if they recover.

At SCPAHFS, the case undergoes a full initial clinical examination and the clinician on duty performs or administers further diagnosis and treatment as required. Euthanasia of the case is performed if the welfare of the case is compromised and/or to complete the diagnosis made after clinical investigations and additional diagnostics. Welfare is not recorded using prescribed metrics but using the clinical opinion of clinician, resident and students looking after the case. The results of these examinations, the additional diagnostics and the post-mortem are then discussed with the referring veterinarian. At all points in this clinical process, there is student teaching involvement; in SCPAHFS there is uniquely a system whereby final year students are given case responsibility under the supervision of two clinical staff, and therefore they take the primary responsibility for case management.

2.3.3 Case definition

For the first aim of the study all recorded cases in the Excel database that had been referred to SCPAHFS between 2013-2022 were included and identified by year, month and weekday of arrival. Cases were recorded by species, sex (categorised as male (entire and neutered), female and unknown), age (0-0.9; 1-1.9; 2-2.9; 3-3.9; 4-4.9; 5-5.9; 6-6.9; 7-7.9, 8-8.9; 9-9.9 to >10 years and unknown), type of animal (in the case of a bovine, beef or dairy). The case was recorded as part of a group case if multiple cases from the same farmer arrived on the same day and with the same referred diagnosis. If they did not have the same referral diagnosis, they were recorded as individual cases.

2.3.4 Disease group

Classification in the different disease groups was based on the recorded diagnosis in the postmortem (PM) diagnosis column within in the Excel database, which was then defined as the main disease category; to adjust for additional diseases, additional findings in the PM diagnosis column were recorded within an additional category (Appendix 2 for bovine cases, ovine cases). If the main category and additional category were involving multiple organ systems, the disease group was recorded as multiple organs affected. If no PM diagnosis was recorded, this was recorded as “no information known”. If no abnormalities were found on postmortem, the diagnosis of ‘Diagnosis not reached’ was recorded. In cases where it was known no PM was performed, it was recorded as ‘no PM performed’, in cases where the animal cadaver was used for other reasons such as teaching, field postmortem classes, surgical classes, this was recorded in the diagnosis category 'other'.

2.3.5 Length of stay in SCPAHFS

To obtain the number of days the case spent in the hospital, the number of days between date of arrival and the date of euthanasia was used. To address the animals that became residents in the clinic and therefore could increase the mean duration substantially, the median value was also calculated per disease.

2.3.6 Distance travelled to SCPAHFS

As there were no records of the actual number of kilometres travelled by the transporter to bring the animal to the SCPAHFS, the road distance between the postcode of the farm and the postcode of the SCPAHFS using the website www.freemaptools.com (freemaptools.com, 2024).

2.3.7 Journey time to SCPAHFS

As there were no records of the actual time taken to transport the animal to SCAPHFS, the time was initially calculated using the time it would take a normal vehicle to travel between the farm postcode and the SCPAHFS with www.freemaptools.com (freemaptools.com, 2024). Although not the whole route was on a motorway, the average speed difference between a lorry and a light vehicle on a motorway was used to adapt the time as an assumption to calculate the journey time. The speed of a lorry compared to a light vehicle on the motorway is by average 5/7 (Aecom, 2019), therefore the journey time of a light vehicle was multiplied by 1.4.

2.3.8 Factors influencing euthanasia within and after 48h of arrival in SCPAHFS of bovine and ovine cases

This part of the analysis was only carried out on bovine and ovine cases and excluded cases that were missing a PM report or euthanasia date (Figures 2-1 & 2-2). The remaining cases were divided between species (1066 bovine case, 537 ovine cases) and between cases euthanised within 48 hours of arrival and cases euthanised after 48 hours of arrival.

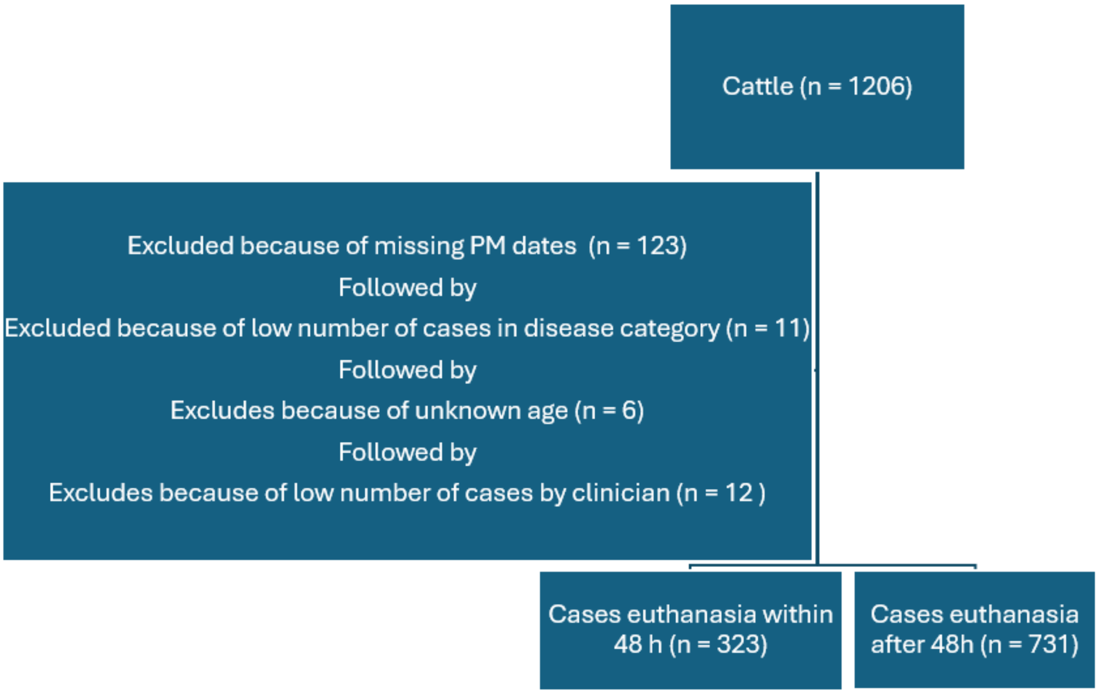

Figure 2-1. Number of cattle cases after exclusion of the cases with missing PM dates followed by exclusion disease categories with low number of cases and exclusion of unknown age category

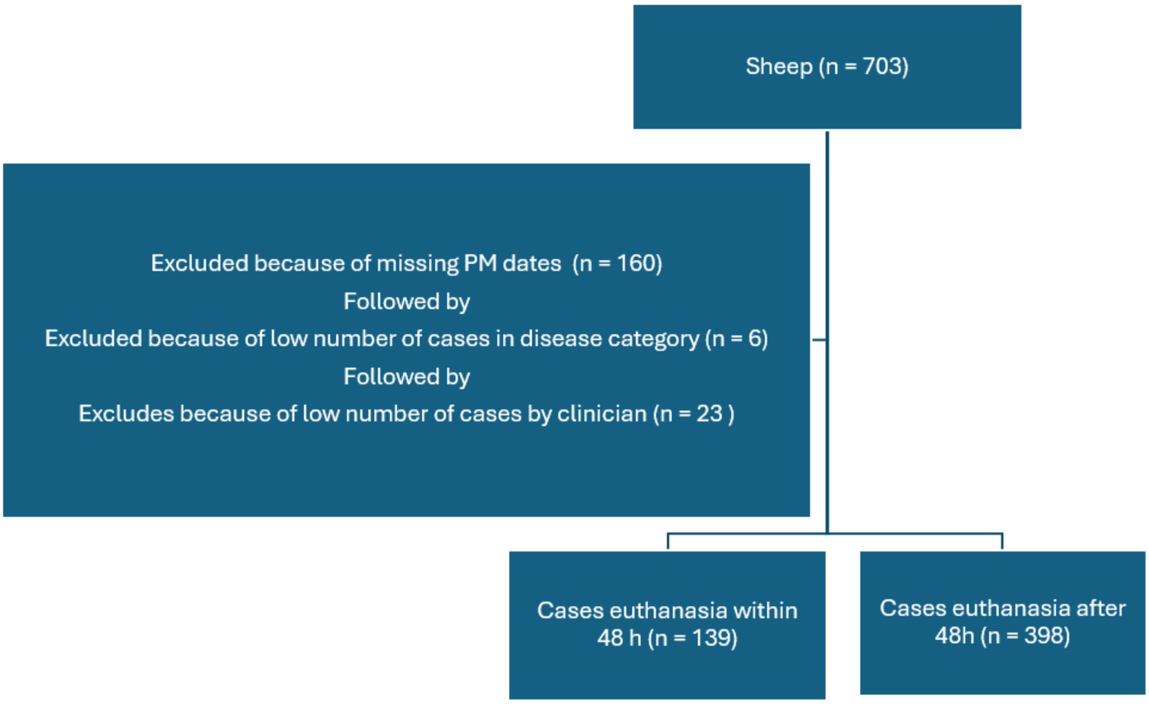

Figure 2-2. Number of sheep cases after exclusion of the cases with missing PM dates followed by exclusion disease categories with low number of cases and exclusion of unknown age category

Factors that were investigated were: month of arrival, weekday of arrival, clinician that was on duty at the time the animal arrived, the disease category of the given postmortem diagnosis, age, animal type (in case of bovine case), distance to SCPAHFS, journey time, sex and individual/group case.

2.3.8 Statistical methods

Descriptive statistics were carried out with R statistical software, version 4.3.3 (R Core Team, 2024). To investigate factors that influenced stay beyond 48 hours, logistic regression was used to calculate an adjusted inverted odds ratio with significance levels set at $p = 0.05$. To investigate which factors to include in the regression, univariant analysis was carried out using a logistic regression test, where factors with $p > 0.2$ excluded. To reduce levels within the categories, data were collapsed and were restructured in the following way:
Age group: the ages 2-<3 and 3-<4 yr were combined to one group (2-<4yr), the group 4-<5 yr and 5-<6yr was combined to one group (4-<6yr), and the groups of 6-<7yr and older were combined to one group (>6yr). The group of 0-0.99yr and 1-<2yr remained individual groups as they had sufficient numbers within the group. Because of the low number bovine cases with unknown age (after removing the cases with unknown PM date), these were removed out from the dataset (Figure 2-1). Because the number of ovine cases with an unknown age was too large to remove, this remained as a category ‘unknown’.

Because not all disease categories had enough numbers within the group, some disease categories were combined; the circulatory and blood producing organs were combined as one group (circulatory, blood producing organs) and the reproductive organs and the mammary diseases (reproductive organs and mammary). The groups of ‘no information’, ‘no PM’ and ‘other’ were also combined as one group (no information, no PM and other). All other disease categories remained individual groups. In the bovine model, the disease categories ‘eyes and ear’ and endocrinology were excluded because of low numbers within these categories (Figure 2-1). In the ovine model the disease categories ‘kidneys, bladder, urinary tract’ and ‘eyes and ears’ were removed because of low numbers within these categories (Figure 2-2).

Because of low numbers in some of the clinician categories, the following clinicians were excluded: for the bovine cases clinician K, clinician O and clinician R and for ovine cases clinician C, L, and P.

The months were combined as pairs of three months; group 1 January to March, group 2 April to June; group 3 July to September, and group 4: October to December.

Final model bovine cases

The factors that were significant ($p < 0.2$) in the univariate analysis (Table A3-1) and included in the multivariant model were month, age, weekday of arrival, clinician, disease category and individual/group case. The factors not included in the model were travel time (p=0.46), travel distance (p=0.46), purpose farm(p=0.33) and sex (p=0.21). Thereafter the model was tested for fitness (Table A3-2) whereafter the factors clinician, month, and individual or group case were removed from the final model. The final logistic regression model for bovine cases with the outcome of stayed less than 48 hours (0) or more than 48 hours after arrival (1) (u_i), with the factors of weekday of arrival (β_j), age (β_k), and disease category (β_l) was as follows:

$$\log \mu_{ijkl} = u_i + \beta_j + \beta_k + \beta_l$$

Reference values were the first day of the week (Monday), the age group that was seen the most (0-0.99 year) and the disease category that was seen the most (digestive diseases).

Final model ovine cases

The factors that were significant ($p < 0.2$) in the univariate analysis (Table A3-1) and included in the multivariant model were month, age, weekday of arrival, clinician, disease category, travel distance, time to travel and sex. The only factor not included was individual or group case. Thereafter the model was tested for fitness (Table A3-3) whereafter the factors month, travel distance, travel time and age were removed from the final model. The final logistic regression model for ovine with the outcome of euthanised within 48 hours (0) or after 48 hours of arrival (1) (u_i) with the factors of weekday of arrival (β_j), sex (β_k), disease category (β_l) and clinician (β_m) was as follows:

$$\log \mu_{ijkl} = u_i + \beta_j + \beta_k + \beta_l + \beta_m$$

Reference values were the first day of the week (Monday), the disease that was seen the most (respiratory diseases) and the sex most frequently admitted (female).

2.4 Results

2.4.1 Demographic data of cases between 2013 and 2022

Between 2013 and 2022, a total of 1,206 cases of cattle and 703 cases of sheep were referred to the SCPAHFS. In addition to these two main animal species, 25 goats, nine pigs, two alpacas and 21 chickens were also referred. In these nine years, the percentage of cows, as a proportion of the total number of cases per year fluctuated between 68% to 46% and the percentage of sheep between 29% and 41% (Table 2-1). For bovine, there is a downward trend visible compared to the beginning of the time period. Slightly more than half (55% of the referred bovine cases and 58% of the referred ovine cases) were female, with 20% of the bovine cases and 13% of the ovine cases male. In 25% of the bovine and 29% of the ovine cases the sex was unknown (Table 2-2).

Table 2-1. Number of cases (and percentage of total cases admitted) per species by year of the submitted cases to SCAPHFS in the period 2013-2022. Before exclusion of data in further analysis. The last four species were excluded from further analysis

	Year									
Species	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Cattle	129 (62%)	154 (68%)	153 (67%)	161 (63%)	135 (63%)	133 (62%)	104 (55%)	68 (65%)	84 (59%)	85 (46%)
Sheep	74 (36%)	68 (30%)	74 (32%)	95 (37%)	76 (36%)	80 (37%)	72 (38%)	31 (30%)	58 (41%)	75 (41%)
Goats	0	3 (2%)	0	0	0	1 (0.5%)	5 (3%)	0	1 (0.7%)	15 (8%)
Pigs	4 (2%)	0	0	0	0	0	2 (1%)	0	0	3 (2%)
Alpacas	0	0	2 (1%)	0	0	0	0	0	0	0
Poultry	0	0	0	0	1(0.5%)	2 (1%)	7 (4%)	6 (6%)		6 (3%)
Total	207	225	229	256	212	216	190	105	143	184

Table 2-2. Number of cases of each sex per species of the submitted cases to SCAPHFS in the period 2013-2022. Before exclusion of data in further analysis. The last four species were excluded from further analysis

		Cattle	Sheep	Goats	Pigs	Alpaca	Poultry
Sex	Female	663 (55%)	409 (58%)	6 (24%)	3 (33%)	0	22 (100%)
	Male	234 (19%)	91 (13%)	16 (64%)	2 (22%)	2 (100%)	0
	Unknown	309 (26%)	203 (29%)	3 (12%)	4 (44%)	0	0
	Total	1206	703	25	9	2	22

In 37% of the bovine cases the animal was referred as a beef breed (pure and cross) and in 63% of the bovine cases it was a dairy breed. The largest proportion of bovine cases (39%) was younger than one year; the largest proportion of sheep cases were cases three to four years old (23%). In one percent of the bovine cases and eleven percent of the ovine cases no age was recorded (Table 2-3).

Table 2-3. Age of case (and percentage of cases) per species of the submitted cases to SCAPHFS in the period 2013-2022. Before exclusion of data in further analysis. The last four species were excluded from further analysis

	Species					
Age category	Cattle	Sheep	Goats	Pigs	Alpaca	Poultry
0-<1 year	464 (38%)	148 (21%)	16 (64%)	5 (56%)	0	12 (57%)
1-<2 year	161 (13%)	76 (11%)	0	0	0	6 (29%)
2-<3 year	125 (10%)	54 (8%)	0	2 (22%)	0	2 (10%)
3-<4 year	117 (10%)	164 (23%)	0	0	0	1 (5%)
4-<5 year	99 (8%)	127 (18%)	5 (20%)	0	0	0
5-<6 year	66 (5%)	37 (5%)	0	0	0	0
6-<7 year	53 (4%)	13 (2%)	2 (8%)	0	0	0
7-<8 year	21 (2%)	8 (1%)	0	0	0	0
8-<9 year	21 (2%)	0	0	0	0	0
9-<10 year	15 (1%)	1 (0%)	1 (4%)	0	0	0
>10 year	45 (4%)	0	1 (4%)	0	2 (100%)	0
Unknown	19 (2%)	75 (11%)	0	2 (22%)	0	0
Total	1206	703	25	9	2	22

The majority of bovine cases were referred as an individual case (89%), while 50% of the ovine cases were referred as individuals and 50% were part of a group. The most common day for cases to arrive was a Wednesday (28%) with 27% arriving on a Tuesday and 25% on Thursday (Table 2-4).

Table 2-4. Number of cases arriving by day of week in the period 2013-2022. Before exclusion of data in further analysis.

	Number of cases arriving
Monday	167 (8%)
Tuesday	532 (27%)
Wednesday	560 (28%)
Thursday	496 (25%)
Friday	212 (11%)

2.4.2 Number of cases per main disease category

For the bovine cases the disease category 'multiple organs involved' contained the most cases (19%), followed by digestive diseases (18%), and respiratory diseases (17%). For ovine cases, respiratory diseases were diagnosed the most (20%), followed by digestive diseases (13%) and the category multiple diseases involved (11%) (Table 2-5). In sixteen percent of the bovine cases and twenty two percent of the ovine cases, no PM diagnosis was recorded. In four percent of the bovine cases and six percent of ovine cases no gross abnormalities were seen on postmortem.

Table 2-5. Number of cases classified by disease category for each species of the cases submitted to SCAPHFS in the period 2013-2022. Before exclusion of data in further analysis.

	Species					
Disease category	Cattle	Sheep	Goats	Pigs	Alpaca	Poultry
Respiratory	206 (17%)	143 (20%)	2 (8%)	0	0	0
Digestive	214 (18%)	90 (13%)	6 (24%)	0	0	1 (5%)
Circulation	36 (3%)	3 (0.4%)	0	0	0	0
Blood producing organs	15 (1%)	5 (0.7%)	0	0	0	0
Skin diseases	14 (1%)	14 (2%)	0	0	0	0
Liver diseases	14 (1%)	16 (2%)	0	0	0	0
Kidneys, bladder, urinary tract	13 (1%)	3 (0.4%)	0	0	0	0
Eyes, ears	10 (0.8%)	3 (0.4%)	0	0	0	0
Multiple systems involved	232 (19%)	79 (11%)	0	0	2 (100%)	0
Endocrinology	1 (0.08%)	0	0	0	0	0
Reproductive organs	18 (1.5%)	9 (1%)	0	0	0	0
Neurology	18 (1.5%)	19 (3%)	0	0	0	0
Mammary	6 (0.5%)	3 (0.4%)	0	0	0	0
Diagnosis not reached	49 (4%)	41 (6%)	0	0	0	0
Musculoskeletal	127 (11%)	63 (0.9%)	1 (4%)	0	0	0
No information	195 (16%)	149 (22%)	9 (36%)	9 (100%)	0	21 (95%)
No PM	15 (1.2%)	31 (4%)	4 (16%)	0	0	0
Other	23 (1.9%)	29 (4%)	3 (12%)	0	0	0
Total	1206	703	25	9	2	22

Overall, the median number of days a case spent in hospital was seven days for cattle (CL 7- 8 days) and eight days for sheep (CL 7-11 days). In bovine cases, diseases of the reproductive tract diagnosed at postmortem had the highest median days in the SCPAHFS (34 days (CL 9-67 days)), followed by eyes and ear diseases (25 days (CL 4-136 days)) and neurological cases (14 days (CL 5-51 days)). One case diagnosed within the endocrinology category was seen in the period 2013-2022 and stayed within the SCPAHFS for 213 days. The disease categories that remained the shortest within in the SCPAHFS were kidney bladder and urinary tract category (2days (CL 1-15 days)), followed by circulatory diseases (4 days (CL 2-8 days)) and blood producing organs (four days (CL 2-12 days)) (Table 2-6).

In ovine cases, diseases of the reproductive tract remained the longest in the clinic (33 days (CL 7-105 days)), followed by liver diseases (25 days (CL 8-41 days)), and eyes/ear (22 days (CL 1-43 days)). The disease categories that remained the shortest within the SCPAHFS were mammary disease (0 days) (which means that they were or euthanised on arrival or on the day of arrival), followed by skin diseases (3 days (CL 1-64 days) and circulation diseases (4 days (CL 2-20 days)) (Table2-6). If no diagnosis was reached by postmortem, bovine cases stayed a median of 21 days (CL 15-47 days) and ovine cases a median of 18 days (13-27 days). Bovine cases on which no postmortem was performed stayed a median of 44 days (CL 1-112 days) and ovine cases a median of 31 days (CL 28-135 days). Cases on which a field PM or cadaver surgery was performed, had a median day of stay of 7 days (CL 6-29 days) for bovine cases and a median day of 4 days (CL 0-18 days) for ovine cases.

Table 2-6. Median days in the clinic by main diseases category per species in the period 2013-2022. After exclusion of missing PM dates.

	Disease group	Median	95.0% Lower CL for Median	95.0% Upper CL for Median
Bovine	Respiratory	8	7	13
	Digestive	7	7	9
	Circulation	4	2	8
	Blood producing organs	4	2	12
	Skin diseases	8	5	27
	Liver diseases	8	3	42
	Kidneys, bladder, urinary tract	2	1	15
	Eyes, ears	25	4	136
	Multiple systems involved	5	5	7
	Endocrinology	213	.	.
	Reproductive organs	34	9	67
	Neurology	14	5	51
	Mammary	8	8	31
	Diagnosis not reached	21	15	47
	Musculoskeletal	7	7	14
	No information	6	4	11
	No PM	44	1	112
	Other	7	6	29
Sheep	Respiratory	6	6	9
	Digestive	13	11	20
	Circulation	4	2	20
	Blood producing organs	7	4	34
	Skin diseases	3	1	64
	Liver diseases	25	8	41
	Kidneys, bladder, urinary tract	16	7	66
	Eyes, ears	22	1	43
	Multiple systems involved	8	6	11
	Reproductive organs	33	7	105
	Neurology	8	2	21
	Mammary	0	.	.
	Diagnosis not reached	18	13	27
	Musculoskeletal	6	5	8
	No information	8	4	14
	No PM	31	28	135
	Other	4	0	18

2.4.3 Median travel distance and travel time per species

For both main animal species, bovine and ovine, the median travelling distance was 70 km for bovine and 68.5 km for ovine. The median journey time for bovine cases was 58.8 minutes and for ovine cases 50.4 minutes (Table 2-7).

Table 2-7. Median distance and travel time to SCPAHFS by species in the period 2013-2022.

	Distance (km)			Travel time (min)		
	Median[a]	95.0% Lower CL for Median	95.0% Upper CL for Median	Median[a]	95.0% Lower CL for Median	95.0% Upper CL for Median
Bovine	70	65.4	74.8	58.8	56	64.4
Ovine	68.5	62.7	72	50.4	42	64.4

2.4.5 Euthanasia within or after 48 hours of arrival and factors that influenced this for bovine and ovine cases

2.4.5.1 Bovine cases

Of the 1,054 bovine cases, 323 (31%) cases stayed less than 48 hours after and 731 (69%) cases stayed longer than 48 hours after arrival (Table 2-8).

In the multivariate analysis, significant effects were observed for weekday of arrival, age, disease category ($p<0.05$). Compared to Monday, the odds to stay less than 48 hours were higher on Tuesday (OR 2.61, CI 1.41-5.06), Wednesday (OR 2.37, CI 1.30-4.54) and Thursday (OR 1.94, CI 1.06-3.75) ($p<0.05$). Compared to the age category (0-0.99yr) the categories 2–4-year, 4-6 year and >6 year had higher odds to stay less than 48 hours [2-4 year (OR 2.33, CI 1.59-3.42), 4-6 year (OR 1.77, CI 1.13-2.77), >6 year (OR 2.33, CI 1.50-3.62)]. Compared to the digestive tract disease group, the odds were higher to stay less than 48 hours (OR 4.86 CI 1.43-18.25) ($p<0.05$) for diseases within the kidney, bladder and urinary tract category. The odds were significantly lower for the group diagnosis not reached (OR 0.36, CI 0.13-0.85) ($p<0.05$).

Table 2-8. Adjusted inverted Odds ratios of bovine cases comparing cases stay less than 48 hours after arrival and stay longer than 48 hours after arrival.

Predictors	Before 48h	After 48h	Adjusted inverted Odds Ratios[a]	CI	p-value
Total cases	323	731			
Day					
Monday	15	66	Reference		
Tuesday	90	157	2.61	1.41 – 5.06	**<0.05**
Wednesday	117	210	2.37	1.30 – 4.54	**<0.05**
Thursday	86	196	1.94	1.06 – 3.75	**<0.05**
Friday	15	102	0.61	0.27 – 1.35	0.219
Age					
0-<1 year	93	308	Reference		
1-<2 year	40	104	1.32	0.84 – 2.06	0.223
2-4 year	86	136	2.33	1.59 – 3.42	**<0.05**
4-6 year	48	100	1.77	1.13 – 2.77	**<0.05**
>6 year	56	83	2.33	1.50 – 3.62	**<0.05**
Disease category					
Digestive	66	147	Reference		
Respiratory	58	143	1.21	0.77-1.91	0.402
Circulation, blood producing organs	20	30	1.80	0.92 – 3.47	0.083
Skin diseases	2	12	0.73	0.11 – 3.11	0.704
Liver diseases	2	12	0.35	0.05 – 1.36	0.180
Kidneys, bladder, urinary tract	8	5	4.86	1.43 – 18.25	**<0.05**
Multiple organs involved	76	152	1.24	0.82 – 1.89	0.311
Reproductive organs, mammary organs	5	19	0.57	0.18 – 1.54	0.302
Neurology	5	13	1.51	0.45 – 4.44	0.475
Diagnose not reached	6	43	0.36	0.13 – 0.85	**<0.05**
Musculoskeletal	41	84	1.48	0.89 – 2.47	0.133
No information, no PM and other	34	71	1.26	0.74 – 2.13	0.390

a. Adjusted for weekday of arrival, age and disease category

2.4.5.2 *Ovine cases*

Of the included 514 sheep cases, 133 (26%) cases were euthanised within 48 hours of arrival and 381 (74%) cases later than 48 hours of arrival (Table 2-9)

In the multivariant analysis significant effects were observed for weekday of arrival, disease category, sex and clinician ($p<0.05$). Compared to Monday, the odds were significantly higher to stay less than 48 hours on a Tuesday (OR 2.69, CI 1.22-6.27) and the odds were significantly lower to stay less than 48 hours on a Friday (OR 0.17, CI 0.03-0.74) ($p<0.05$). Compared to the respiratory disease category, the category 'diagnoses not reached' had lower odds to stay less than 48 hours (OR 0.14, CI 0.03-0.46) ($p < 0.05$). Although not significant the digestive disease category had a trend to have lower odds to stay less than 48 hours than cases in the respiratory disease category (OR 0.51, CI 0.25-0.99, p = 0.051) together with the category 'No information, no PM and other' (OR 0.50, CI 0.23-1.04, p = 0.07). For sex, the male and unknown category had higher odds to stay less than 48 hours compared to females [male (OR 2.29, CI 1.19-4.38), unknown (OR 2.17, CI 1.21-3.88) p<0.05]. Compared to clinician A, Clinician P being on duty when the case was admitted had higher odds for an ovine cases staying less than 48 hours (OR 3.71, CI 1.09-13.03) (p<0.05). A trend was also visible for clinician G for having lower odds to have cases staying less than 48 hours after arrival (OR 0.42, CI 0.14-1.11) (p = 0.096).

Table2-9. Adjusted inverted Odds ratio and P-values of sheep cases between cases euthanised within 48 hours of arrival and euthanised after 48 hours of arrival.

Predictors	Stay less than 48 hours	Stay longer than 48 hours	Adjusted inverted Odds Ratios[a]	CI	p-value
Total cases	133	381			
Day					
Monday	12	37	Reference		
Tuesday	54	106	2.69	1.22 – 6.27	**<0.05**
Wednesday	43	105	1.72	0.77 – 4.03	0.200
Thursday	22	81	1.02	0.43 – 2.49	0.966
Friday	2	52	0.17	0.03 – 0.74	**<0.05**
Sex					
Female	65	257	Reference		
Male	26	43	2.29	1.19 – 4.38	**<0.05**
Unknown	42	81	2.17	1.21 – 3.88	**<0.05**
Disease category					
Respiratory	43	91	Reference		
Digestive	16	69	0.50	0.24 – 1.01	0.060
Circulation, blood producing organs	1	5	0.42	0.02 – 3.40	0.468
Skin diseases	4	10	0.79	0.18 – 2.90	0.727
Liver diseases	1	11	0.22	0.01 – 1.25	0.159
Multiple systems involved	17	57	0.61	0.30 – 1.20	0.158
Reproductive organs, mammary organs	3	7	0.79	0.13 – 3.77	0.781
Neurology	6	11	1.43	0.39 – 4.93	0.580
Diagnosis not reached	3	33	0.14	0.03 – 0.46	**<0.05**
Musculoskeletal	25	36	1.18	0.58 – 2.40	0.641
No information, no PM and other	14	51	0.50	0.23 – 1.04	0.070
Clinician					
Clinician A	33	82	Reference		
Clinician B	20	58	1.00	0.49 – 2.03	1.000
Clinician D	0	15	0.00	NA – >100	0.978
Clinician E	29	49	1.57	0.79 – 3.13	0.196
Clinician F	20	75	0.70	0.34 – 1.40	0.312
Clinician G	6	37	0.42	0.14 – 1.11	0.096
Clinician H	1	10	0.21	0.01 – 1.22	0.150
Clinician I	7	12	1.37	0.40 – 4.51	0.604
Clinician J	2	9	0.51	0.07 – 2.44	0.442
Clinician O	2	14	0.80	0.11 – 3.62	0.791
Clinician P	8	7	3.71	1.09 – 13.03	**<0.05**
Clinician R	5	13	0.64	0.17 – 2.14	0.483

a. Adjusted for weekday of arrival, sex, disease category, and clinician

2.5 Discussion

This study describes the demographics of cases referred to the SCPAHFS during the period 2013-2022, specified by species, age, postmortem diagnosis and median days of stay in SCPAHFS by disease, and made a first attempt to investigate the factors that might influence whether a case stayed less than 48 hours after arrival. The number of cases referred to the VTH fluctuated from year to year, with a significant drop in cases in 2020 when the COVID pandemic prevented cases from being referred to the hospital because the SCPAHFS was temporarily closed to cases and to students. While 38 % of the referred bovine cases were younger than one year of age, this was only the case for 21 per cent of the referred ovine cases. Most of the referred ovine cases were older ewes: 23 per cent in the 3 to 4 years-old age group and 18 per cent in the 4 to 5 years-old age group. The fact that more older ewes were referred compared to the bovine cases is most likely because 50 % of the ovine cases were referred as part of a group for pathological ill-thrift investigation. This result differs from the findings of the 2017 study by Wäsle et al. in which they described that cattle older than two years were the most referred age group of cattle admitted to their veterinary teaching hospital. A difference between SCPAHFS and the VTH described by Wäsle et al. (2017) is that cases referred to SCPAHFS do not return to the farm of origin while in that study they can return to the farm. This will potentially influence the age of the case that is referred SCPAHFS (Wäsle et al., 2017).

Digestive and respiratory diseases were the most common disease categories diagnosed at postmortem of the bovine cases (regardless of age), which is consistent with previous published studies (Gardner et al., 1990; Esslemont and Kossaibati, 1997; Svensson et al., 2003; Østerås et al., 2007; Gulliksen et al., 2009; Blanchard, 2012) describing the disease prevalence of bovine cases on farm and at culling. For the ovine cases, digestive and respiratory diseases were also the most common disease categories at postmortem; for the digestive tract disease group, this is consistent with previous studies by Dohoo et al. in 1985 and Ridler et al. in 2024 as intestinal parasites and broken mouth are included in this category. However, the high percentage of diseases in the respiratory category is not consistent with the earlier studies (Dohoo, Curtis and Finley, 1985; Wäsle et al., 2017; Ridler et al., 2024) in which they give reasons for culling, but is consistent with Animal and Plant Health Agency (APHA) and Scotland's Rural College (SRUC) surveillance reports from 2021 and 2023, which report a high number of cases of respiratory disease, pneumonia and OPA. One reason that respiratory disease is not high on the list of reasons for culling could be that, from the farmer's perspective, ill thrift is easily recognised as a clinical presentation, rather than possible subtle respiratory distress and, therefore, could mean that a proportion of cases culled because of ill thrift are caused by respiratory disease. The low percentage of cases within the category of diagnosis not reached in one per cent of bovine and four per cent of ovine cases shows first a high diagnostic rate, but it does not mean that the case had no clinical signs: sometimes the changes that cause clinical signs are not present at the time of post-mortem. This is particularly true for changes in the digestive tract such as abomasal displacement, rumen tympany or vagal indigestion syndrome (Fubini *et al.*, 1985; Sattler *et al.*, 2000) and in some cases a definitive diagnosis requires additional histopathology, which was not always been performed due to financial constraints. In some cases, animals remain as static animals in the SCPAHFS after clinical recovery and are used for teaching purposes until they are replaced by newer static animals.

Although the median days of stay in the SCPAHFS for all bovine and ovine cases was similar (seven days and eight days respectively), individual variance between cases and diseases was noted. The low median days of stay of the bovine cases for the specific disease categories (circulatory and blood producing organs) could reflect the severity of the specific disease category in the case of circulation disease (Buczinski *et al.*, 2010), or it could be due to a larger number of different diseases with possibly different severity which were included in the other disease category definitions, resulting in a higher median length of stay in the hospital; this could be the case for diseases in the respiratory category; cases of chronic pneumonia stayed usually longer (10-14 days). The longer median duration of stay for both bovine and ovine for reproductive diseases (bovine 34 days, ovine 33 days) could be due to the disease having a lower impact on the health and welfare status of the animal and therefore allowing it to be used for teaching for longer; for example, pseudo hermaphroditism or ovarian neoplasia have less impact on the status of the animal compared to respiratory and circulation diseases (Pérez-Martínez *et al.*, 2004). The low median length of stay of sheep in the circulation disease category and mammary disease categories most likely also reflects the severity of the disease (Mørk *et al.*, 2007). The low median days in SCPAHFS for skin diseases is interesting because it could reflect the severity of the diseases diagnosed within this category. Not considered in this study (due to logistical constraints), but a potential confounding factor for length of stay in the clinic could be the time between the referring veterinarian contacting the SCPAHFS and the case being picked up from the farm. Cases are categorised by the clinician or resident on duty into high, medium and low priority to ensure that critical cases are collected as quickly as possible. The relationship between the time between first contact of referring veterinarian and the time of arrival in the VTH need to be further investigated to see if it influences the length of stay within SCPAHFS.

The type of case referred to SCPAHFS is different compared to what is seen is practice; SCPAHFS receives mainly chronic cases, and less acute cases (Sala, 2016). The referral of the case is dependent on whether the farmer is willing to send the case, if the referring veterinarian has time to arrange the referral and if that animal is fit to transport. Potentially this could influence the length stay of the case negatively, although in SCPAHFS numerous cases recover and remain for longer time within SCPAHFS. Another factor that is not included in this study is the decision for euthanasia; the decision for euthanasia is mainly based on the welfare, clinical progression of the case and to obtain a diagnosis through PM. Some of the cases are also euthanised to be used for a teaching surgery class and this could therefore also influence the length of stay of the cases.

The influences on euthanasia within 48 hours and after 48 hours of arrival in bovine showed that cases arriving on Tuesday, Wednesday and Thursday had significantly higher odds of staying less 48 hours than cases admitted on Monday, and that cases arriving on Friday had slightly lower odds to be euthanised within 48 hours than cases arriving on Monday; a possible explanation that the odds are higher on Tuesday, Wednesday and Thursday for staying less than 48 hours after arrival could be that because on Friday usually no PMs are performed (as the PM is reserved for emergency diagnostic cases) so the cases are euthanised before Friday so that the carcasses can be submitted in good condition to the PM room, while cases arriving on a Friday cannot have a PM and are therefore moved over the weekend before they are euthanised. This is only done if the clinical condition of the animals allows waiting over the weekend, if the condition is considered to be too negative for the welfare of the animal the animal is euthanised to prevent further suffering. The age of the bovine cases influences the odds of being euthanised within 48 hours or after 48 hours of arrival; cases with an age above two years have significantly higher odds to be euthanised within 48 hours after arrival than cases up to 1 year of age: this may reflect the severity of the disease in cows compared to calves. Compared to the digestive disease category cases diagnosed in the disease categories of kidney, bladder and urinary tract had significantly higher odds to stay less than 48 hours after arrival; this is most likely a reflection of the severity of the disease and is in line with the low median days in SCPAHFS. The lower odds to stay less than 48 hours after arrival when a diagnosis is not reached on PM suggest that the clinical status of the animal was not severe.

Factors affecting euthanasia within 48 hours of arrival of ovine cases showed that cases arriving on a Tuesday had significantly higher odds to be euthanised within 48 hours after arrival than cases arriving on a Monday. Cases arriving on a Friday had significantly lower odds to be euthanised within 48 hours after arrival than cases arriving on a Monday – i.e. a pattern that was broadly similar to bovine cases. This could mean that cases arriving on Tuesday are more severe in clinical status than cases arriving on Monday, it could be a consequence of using Monday as reference factor while it has a lower number of cases than Tuesday. However, given the different nature of ovine cases compared to bovine cases (older animals and more likely to be in a group) this is interesting to note that the day of the week effect still holds. This suggests that there are strong external factors related to the structure of the teaching week that impact on decision-making. Some of these relate to teaching use and to postmortem service capacity which is not constant. Compared to the cases that fell into the respiratory category, cases diagnosed with digestive disease category were less likely to stay less than 48 hours after arrival. It could reflect that those cases in the respiratory disease category had a more severe disease status, but it is also possible that other factors influenced the decision to euthanise. Lower odds to stay less than 48 hours after arrival were also observed for the categories if no diagnosis was made and the category no information, no PM and other. For the diagnosis not reached category, possible explanations could be that no additional tests/histopathology were performed or that the reason for euthanasia was not due to signs of disease but for other unknown reasons. The fact that the category of no information, no PM and other category had a lower odds of staying less than 48 hours after reflects most likely that their clinical status was not severe. The higher odds of staying less than 48 hours after arrival for male and the unknown sex is interesting but difficult to interpretate as no sex was recorded. Further investigation is necessary why no recording has been performed and how record keeping can be improved. The differences in odds between clinicians is interesting but need to be more investigated to understand the relation between disease and clinician and the clinical condition at moment of arrival and euthanasia.

Further investigation into the relationship between the different factors such as month of arrival and diseases; weekday of arrival and disease and age and disease is needed as this could explain some of the differences observed in this study. An important factor that was not considered in this study but should be included in the next study is the reason for euthanasia along with the clinical diagnosis and clinical status at the time of euthanasia. This could have provided more and better explanations for the observed differences between the various factors. Another factor that should be further investigated is the effect of the waiting time (the time of the first contact of the veterinarian to refer the case to SCPAHFS and the date of arrival in SCPAHFS) on duration of stay at the clinic. The use of the Excel database as the main source for PM diagnosis with the actual PM report within the case records not consulted to confirm this information could have created a bias on the information used for this study as the excel database relied on the interpretation of the resident completing the record. Further investigation needs to be done if the data provided on the database correlates with the data within case records and why the data are missing on the database, not only for the PM diagnosis but also for age, missing PM dates etc. To investigate the effect of clinician, it would be good to look at more individual clinicians, investigating their demographics (years of experience, gender, specialism) and possibly investigate their reasons for euthanasia in relation to the disease, as the reasons for euthanasia could differ between clinicians (Deelen et al., 2023) .

As the length of stay within SCPAHFS is not always a reflection of disease status but depends on the decision at moment of euthanasia, it is not directly related to the welfare of the animal in SCPAHFS. To investigate the welfare of the animals during their stay within SCPAHFS, especially the static animals, it would be good to investigate how many cases show a combination of indicators of neutral and positive welfare and how many cases change from having negative welfare indicators, by using tools such a pain scores, to more positive welfare indicators, like social behaviour and play (Wemelsfelder and Farish, 2004a; Mellor and Beausoleil, 2015; Mellor, 2017).

That a substantial number of cases are euthanised within 48 hours after arrival, raises the question if the transport of these cases to SCPAHFS for the potential teaching benefit overweighs the impact of the disease and transport on the welfare of these cases. As the clinical status the moment before transport is not known/not recorded, it would be good to start recording the clinical status before transport and to investigate this in relation with the referral diagnosis and postmortem diagnosis to see if it could be prevented that animals with a severe clinical status could be submitted. In addition, further investigation in the teaching benefits of cases that stayed less 48 hours is necessary to understand what these teaching benefits are compared to cases students would see in practice.

Although this study is limited in terms of the details of the postmortem diagnosis and has a deficiency in comparing the postmortem diagnosis with the clinical diagnosis and clinical symptoms at the time of euthanasia, it demonstrates that SCPAHFS receives cases with potentially good teaching value in all disease categories for undergraduate and postgraduate students. The diversity of teaching cases should allow students to learn and benefit from all aspects of veterinary medicine in these cases. Of the factors that influence whether a case is euthanised within 48 hours of arrival or after 48 hours of arrival, the weekday of arrival appears to play an important role; arrival on a Friday, although not significant in bovine, appears to have a lower odds of staying less than 48 hours after than arrival on other days.

Bovine diseases within the kidney, bladder and urinary tract disease category appear to have higher odds to stay less than 48 hours after arrival than cases of other disease categories and perhaps the welfare of these cases should be more carefully considered before referral and they should be prioritised for collection to avoid delay between referral and collection. The observation that the transport distance or time does not appear to have a significant effect on whether a case is euthanised within 48 hours of arrival is reassuring for both bovine and ovine although this needs to be more investigated, especially in ovine cases. To minimise the impact on animal welfare when used for teaching purposes, further research is required on bovine cases within the kidney, bladder and urinary tract to understand the length of stay in relation to this disease.

Chapter 3

Investigating the behavioural responses of sheep used for teaching veterinary undergraduates

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3.1 Abstract

3.1.1 Background

The use of animals for teaching veterinary medicine to veterinary students could induce stress for the animals that are used and therefore impact on the welfare of these animals.

3.1.2 Methods:

Six, non-pregnant, Easy-Care ewes were used for clinical examination classes for veterinary students once a week, for five consecutive weeks. A cumulative total of 129 students examined the sheep during these classes. Sheep behaviour was video recorded before, during and after these classes, and subsequently categorised using a bespoke ethogram into maintenance or stress behaviour. Data were analysed to describe the patterns of behaviour seen before, during and after teaching, to see if there was habituation of stress behaviour over the five weeks and to investigate what factors influenced stress behaviour.

3.1.3 Results

Individual differences between sheep for both the number of stress counts and the type of stress response were observed. Over the classes, total stress counts decreased between classes on day one and classes on day five. On day 2 and 3, sheep spent more time lying and eating and on day 4 and 5 less time standing after being used for teaching.

3.1.4 Limitations

The individual differences between sheep in combination with the low number of sheep and observational time could have affected the outcomes of the study.

3.1.5 Conclusion

Sheep are stressed by being used for clinical examination classes, with a variable response between individual sheep. They show habituation towards clinical examination classes, but need time to recover and rest after being used for teaching.

3.2 Introduction

Being capable of performing a clinical examination is a day one competency as described by the Royal College of Veterinary Surgeons (RCVS) and the European Coordinating Committee on Veterinary Training (ECCVT) (ECCVT, 2019; RCVS, 2021). In the undergraduate veterinary curriculum at the University of Glasgow, all students are trained to perform clinical examinations on sheep, as well as cattle, horses and companion animals. During clinical examination training, sheep are used with consideration of the three Rs (Replacement, Reduction, Refining) as proposed in 1959 for the first time by Russel and Burch (and refined afterwards) (Russell and Burch, 1959) and guidelines such as those provided by the American Association of Veterinary Medical Colleges (Hunt, Beaver and Hendrickson, 2022). Although the sheep used for teaching are handled with respect and care during these classes, restraint for handling and contact with students could be a stressor and, therefore, could cause a stress reaction in the sheep due to their fear of novelty and humans (Dwyer, 2004; Wemelsfelder and Farish, 2004).

The behavioural response of a sheep to a stressor is affected by physiological pathways such as activation of the endocrine and nervous pathways which can be different between individual sheep (Dodd et al., 2012). The behavioural responses to stress demonstrated in sheep partly originates from them being a prey animal (Moberg, 2000; Dwyer, 2004). The presence of fear (to humans for example) can lead to behavioural responses such as flight or immobilization (Cockram, 2004; Wemelsfelder and Farish, 2004b; Rault, 2012). The manifestation of the behavioural response can also be partly influenced by the breed, sex, and reproductive status of the sheep (Le Neindre et al., 1993; Vandenheede and Bouissou, 1993; Viérin and Bouissou, 2001; Archer and Khalid, 2004). Besides showing specific stress behaviours, a reduction in normal maintenance behaviours (such as rumination, lying, social behaviours, eating/drinking) can also be observed in response to a stressor (Constable et al., 2016). Habituation or aversion to a particular stressor have been reported in sheep and may depend on the conditions in which the animals were raised and on previous human-animal interactions (Rushen, 1986; Mateo, Estep and Mccann, 1991; Erhard, Elston and Davidson, 2006; Grissom and Bhatnagar, 2009; Hemsworth et al., 2011; Zulkifli, 2013).

The stress response of sheep associated with veterinary student training of clinical skills such as clinical examination, and any potential habituation, has not been described before. However, in cattle, the relationship between prior experience (provided by simulation) of students in a rectal examination procedure and the effect on the cattle used for teaching found that simulator trained students induced a lower stress response in teaching cattle, compared to the non-simulator trained students (Giese et al., 2018).The main objective of this study was to address a knowledge gap in the behavioural responses of sheep to clinical examination teaching. The primary aims were: to establish levels of stress and evidence of habituation experienced by sheep during teaching; to investigate the differences in maintenance behavior before, during and after teaching; and to investigate the factors that influence stress behavior. It was hypothesised that sheep would show stress behaviours during teaching and that habituation would occur after being used for teaching once a week for five weeks.

3.3 Material and Methods

Six non-pregnant, six-year-old ewes (Easycare, mean weight 67 kg (50kg - 83.5kg), were used in the clinical examination classes. The ewes were recruited from the University of Glasgow farm commercial flock and had not previously been used for veterinary teaching classes, or for other research. They arrived one week before the start of the study and were housed within the on-campus teaching hospital in two, group housing pens when not used for teaching (6m by 2.7m, each pen contained three ewes) to acclimatise them. The housing pens were bedded with straw, ewes had ad-libitum access to hay and water and were fed 0.2kg of concentrates per head once per day. The study was approved by the Animal Welfare and Ethics Committee of the School of Veterinary Medicine at the University of Glasgow (EA 52/21).

3.3.1 Clinical examination classes and students

The five clinical examination classes were held once a week, on the same day and same time of the day each week, for five consecutive weeks from mid-January 2022 to the end of February 2022. The clinical examination class was divided into two one-hour sessions and for each hour, only three sheep were used (one sheep from one housing pen, two sheep from the other housing pen), so that over the total two hours all the six sheep were used. To use the sheep for the clinical examination classes two small temporary triangle-shaped pens (1.8m each side) constructed of hurdles were placed within each housing pen. Ten to fifteen minutes before the start of the class, three sheep were placed in three of the four the small triangle-shaped pens, (one sheep per triangle pen) (Figures 3-1 and 3-2), the remaining three sheep were loose within the housing pens (one in one pen and two in the other). After one hour of clinical examination, the sheep in the small triangle pens were exchanged with the other three sheep that had been loose and not yet used.

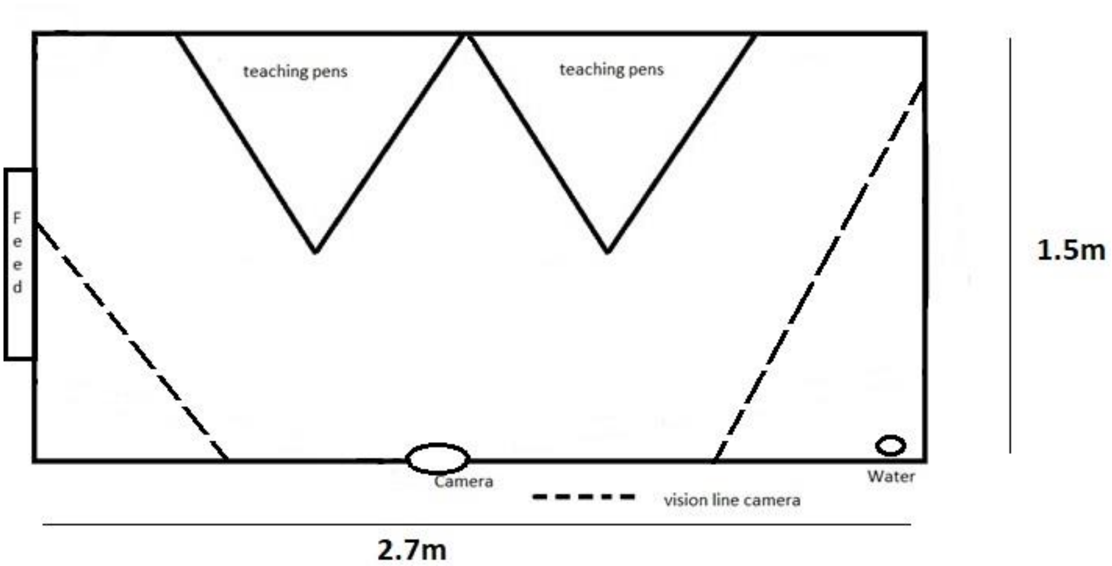

Figure 3-1. Design of the housing pen when small triangle pens are set up. Vision line of camera is also present in this figure.

Figure 3-2. Overview of camera perspective when the sheep were used for teaching

During each teaching hour that sheep were used for clinical examination classes, eight students were in the class and had the opportunity to perform a full clinical examination, students were asked not to tip the sheep they were examining in the triangle-shaped pens. A 'teaching session' was defined as the time a student took to examine a sheep. Sometimes another student joined an existing student; the moment of joining was recorded as the beginning of a new teaching session and the end of the existing student’s session. If a student returned to a sheep they had previously examined (even if another student had examined that sheep in between) that student's return to the sheep was also recorded as a new teaching session and the end of the previous session; however, it was also recorded that it was the second time the student was using the same sheep. If there was more than one person in the triangle-shaped pen, this was recorded as >1 person.

Study participants were 129 second year veterinary undergraduate students. Prior animal handling training was delivered during a practical sheep handling class in their first year; in addition, some students may have also spent time on a lambing placement as part of their Extra Mural Studies (EMS). Prior to the classes students were expected to prepare themselves by watching video material demonstrating sheep clinical examination. One clinician was available to assist during the classes, but no demonstration was given at the start of each class. At the beginning of the class, students were asked if they agreed to be filmed while performing the clinical examination, and to sign a consent form if they agreed. Clinical examination was performed as written by Lovat in 2010, but without tipping the sheep for feet inspection.

3.3.2 Camera system

Two cameras (Sony Starvis (2MP) Model, KH-778 VR) were used to capture video footage of the ewes. The cameras were placed in the pens before the ewes arrived at the on-campus teaching hospital. They were positioned at a height of 2.1m so that the small triangle pens and most of the housing pens could be filmed (Figure 3-1). The footage was stored on a Digital Video Recorder (Guardian AHD-DVR -8G recording system) and downloaded to an external hard drive each day. The data were then backed up to a second hard drive and stored on the university's server.

3.3.3 Behavioural observations

On the day of the clinical examination classes the maintenance and stress behaviour of the ewes was observed during three periods: Before teaching, during teaching, and after teaching (Table 3-1). Before teaching and after teaching the sheep were in the housing pen without having the small triangle pens within the housing pen. During these periods usually no persons were in SCPAHFS other than occasionally the stockperson.

Table 3-1. Description of approaches used to assess behaviour in study sheep

Time Period	Behavioural assessment technique used	Duration of assessment (minutes)	Pen type
Before Teaching	Scanning & counts	60	Housing pen
During Teaching	Scanning & counts	65-70 *	Triangle pen
After Teaching	Scanning & counts	60	Housing pen

* actual time used for teaching could be different, dependent on the number of students that examined each sheep and time the examination took

To observe the behaviour of the ewes, an ethogram (Table 3-2) was created by the authors using a combination of published literature on sheep behaviour (Dwyer & Bornet, 2004; Machado & da Silva, 2020; McLennan et al., 2016; Williams et al., 2021))and by watching two sheep for one hour each during the teaching period to observe what behaviours were exhibited by the sheep when they were being handled and not handled. To establish the time period for a scanning interval, the same period and same two sheep were observed. Scanning intervals of 5,10 seconds, and 20 seconds were then applied to establish the interval which included enough detail without compromising the quality of the behavioural observations. A scanning interval of 10 seconds was thereafter chosen to be used as interval for the maintenance behaviour. For the observations of stress behaviour, a scanning interval of 10 seconds was judged to be too long, as stress behaviours are short lived and sporadic so continuous observation, counting the stress behaviour was performed to quantify the stress behaviour.

Table 3-2. Ethogram of maintenance and stress and behaviour

Behaviour	Description
Maintenance behaviour	
Lying	Sternal position and ventral sternum touch the ground. The legs are under or beside the animal
Eating	Eats hay or concentrate feed
Standing	Standing still, and no other behaviours are observed. All 4 feet touch the ground
Ruminating	Rumination (movement of the jaws) while in standing or lying position
Walking	Placing more than two steps in forward direction
(Assumed) Urinating	Bending hind limbs so that back is pointing towards the ground
Social behaviour	Includes behaviour such as sniffing or attacking (head butting) other sheep
Other behaviour	Other behaviour that is not described in this ethogram
Not visible	Not visible on video recording
Stress behaviour	
Dropping on two/four legs	Falls to ground, only standing on back legs or completely lies down (sternal position)
Escaping	Movement away from human when touch by human or because of near proximity of human
Immobilisation	Being frozen/not moving when being touched by students/teacher or when students/teacher are around in the pen. No movement of the head visible, or sheep was in a docile posture.
Other behaviour	Ewe shows other behaviour that is not described in this ethogram

3.3.4 Behavioural software

For the recording of behaviour, the open-source programme BORIS was used, as described by Friard and Gamba (Friard and Gamba, 2016) together with Microsoft Excel (Microsoft Corporation, 2022).

3.3.5 Statistical analysis

Descriptive statistics and statistical analyses were performed with R Statistical Software version 4.3.3 (R Core Team, 2024)

3.3.5.1 Stress counts

For the statistical model all the observed stress behaviours (dropping and escaping) were combined to give a total stress count value. As the stress behaviour was recorded as counts, the distribution was right skewed and therefore the Poisson statistical model or negative binomial linear model were considered as the most appropriate choice.

Before using the final model, univariate analysis on the following variables was performed: day (1,2,3,4,5), teaching session within the day (1,2,3,4,≥5), number of people in the pen (1 and >1), housing pen (1,2), hour of being used in clinical examination classes (1,2).

For the final model the negative binomial mixed linear model resulted in a lower Akaike information criterion (AIC), therefore, this model was used to investigate the following explanatory variables on the outcome of total stress count (u_i): day (1,2,3,4,5) (β_j), teaching session within the day (1,2,3,4,≥5) (β_k), number of people in the pen (1 and >1) (β_l), the effect of day x teaching session (ν_{jk}), and the effect of the logarithm of the time/min as an offset (γ_t):

$$\log \mu_{ijklt} = u_i + \beta_j + \beta_k + \beta_l + \nu_{jk} + \gamma_t$$

Sheep was included in the model as a random effect (N):

$$u_i \sim N(0, \sigma^2)$$

Day one, and session one were used as reference.

3.3.5.2 Maintenance behaviour

Behavioural scanning analysis data were converted into a proportion of the total observations in the time the animal was visible. As the only maintenance behaviour observed during the teaching was standing behaviour, and no other maintenance behaviour was observed, it was decided to exclude the teaching period from the statistical part of the analysis. Beta regression (Douma and Weedon, 2019) within a generalised mixed model was used to investigate the differences between time periods (before or after teaching) on the same day. Within the beta regression the effect of day (1,2,3,4,5) (β_j) and the effect of day x time period were included (ν_{jk}) together with the proportion of time (u_i):

$$\text{logit } \mu_{ijk} = u_i + \beta_j + \nu_{jk}$$

Sheep was included in the model as a random effect (N):

$u_i \sim N(0, \sigma^2)$

Day one, and the period before teaching were used as reference.

3.4 Results

3.4.1 Descriptive results of sheep behaviour observations before, during and after teaching

The behavioural observations of the before- and after-teaching periods were a fixed period - one hour before and one hour after teaching, resulting in a total observation of five hours before teaching and five hours after teaching per sheep (Table 3-3). During teaching, the total time for stress count observations was variable ranging from 18 minutes to 60 minutes. The total time when sheep were out of the detection range of the cameras, or not visible because the student positioned themself in front of the sheep was below 3% of recorded teaching time for all sheep on all days.

Table 3-3. Number of recorded hours per sheep before, during and after teaching

	Sheep 1	Sheep 2	Sheep 3	Sheep 4	Sheep 5	Sheep 6
Before teaching						
- recorded hours	5	5	5	5	5	5
- time (%) animal not visible on camera	0	0	0	0	0	0
During Teaching						
- time (min) animals used in classes	243	236	181	176	225	228
- time (%) animal not visible on camera	1.3%	2.8%	1.3%	1.3%	1.4%	0%
After teaching						
- recorded hours	5	5	5	5	5	5
- time (%) animal not visible on camera	11.6%	22.90%	4.8%	1.7%	3.4%	2.6%

After teaching, the sheep were able to use the whole housing pen and therefore sometimes positioned themselves outside the range of the cameras, some sheep for more than 22% of the time in total. Behaviour was recorded as a proportion of the time a sheep was visible on camera. Sheep were never out of camera range before teaching. The total number of teaching sessions per sheep per day and in total over the five days was variable (Table 3-4); this was partly because students sometimes chose to examine an extra sheep or join another student and examine a sheep together. Stress behaviour was only seen during the teaching period when the sheep were examined by students or clinicians and not in the period before or after teaching as there wasn't human interaction with the animals in these periods. Maintenance behaviour, other than standing behaviour, was not observed in the teaching period.

Table 3-4. Number of teaching sessions per day per sheep

	Day 1	Day 2	Day 3	Day 4	Day 5	Total
Sheep 1	6	5	3	8	7	29
Sheep 2	5	5	3	7	7	27
Sheep 3	5	2	1	5	2	15
Sheep 4	9	0	9	7	5	30
Sheep 5	4	5	5	3	4	21
Sheep 6	2	6	6	4	3	21

3.4.2 Stress counts

Stress behaviour was observed in all the teaching sessions on all days, with most stress counts (counts per hour) observed on day one (Figure 3-3). No differences in stress behaviour between sheep being used in the first or second hour of the clinical examination classes ($p = 0.99$), nor differences in stress counts between the two different housing pens were observed ($p = 0.24$). Compared to day one, the stress counts were lower on day four and day five ($p < 0.05$, Figure 3-3).

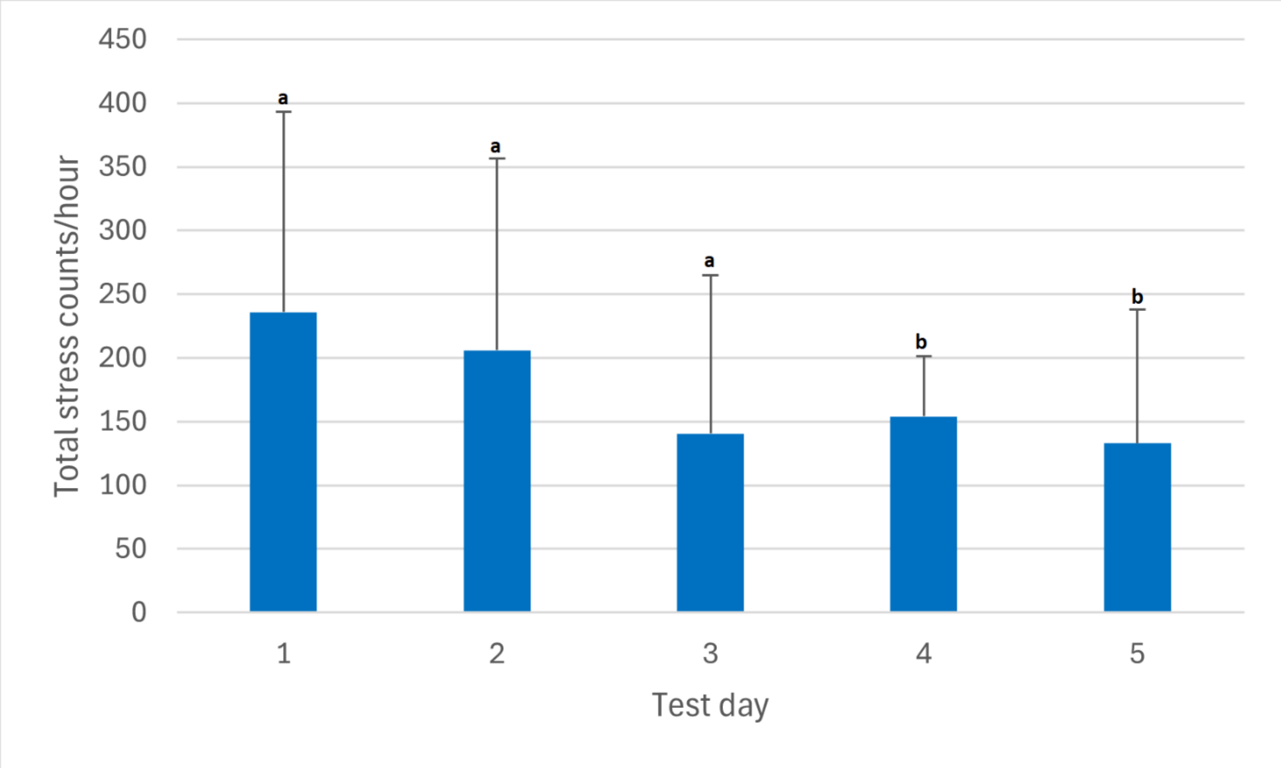

Figure 3-3. Adapted total stress counts per hour for all sheep per test day. The error bars are standard deviations. Different letters (a and b) indicate: a: no significant difference compared to day 1, b difference to day 1 ($p < 0.05$)

Although, overall, there was an effect of session (the time it took a student to do an examination), where all combined (across all days) sessions four, had fewer stress counts than all combined sessions one ($p < 0.05$), the interaction between day and session did not reveal a clear pattern, where there was considerable variability between day and individual student (Table 3-5). When there was more than one person in the pen, there was a tendency for fewer stress counts to be observed compared to when there was only one person in the pen ($p < 0.052$). Between individual sheep, differences in total stress counts were observed (Figure 3-4). Sheep Two showed the least stress behaviour, and sheep Five the most. Escaping was the most frequently observed stress behaviour in all sheep apart from sheep six, which spent a higher proportion of time dropping down. (Figure 3-4).

Table 3-5. Incidence Rate Ratios and Confidence Interval (CI) of effects of number of people, day, session, and interaction of day x session on stress counts in negative binomial mixed linear model. Bold font indicates statistical significance ($p < 0.05$)

	Counts		
Predictors	*Incidence Rate Ratios*	*CI*	*p value*
Number of people = 1	0[a]	.	.
N people >1	0.48	0.23 – 1.01	0.052
Day 1	0[a]	.	.
Day 2	1.04	0.48 – 2.26	0.924
Day 3	0.57	0.27 – 1.17	0.124
Day 4	0.27	0.12 – 0.60	**<0.05**
Day 5	0.33	0.15 – 0.74	**<0.05**
Session 1	0[a]	.	.
Session 2	0.58	0.26 – 1.26	0.169
Session 3	0.6	0.28 – 1.30	0.196
Session 4	0.3	0.13 – 0.70	**<0.05**
Session ≥5	0.62	0.28 – 1.36	0.231
Day 1 × Session 1	0[a]	.	.
Day 2 × Session 1	0[a]	.	.
Day 3 × Session 1	0[a]	.	.
Day 4 × Session 1	0[a]	.	.
Day 5 × Session 1	0[a]	.	.
Day 1 × Session 2	0[a]	.	.
Day 2 × Session 2	0.37	0.08 – 1.79	0.215
Day 3 × Session 2	1.26	0.42 – 3.77	0.681
Day 4 × Session 2	5.1	1.53 – 17.06	**<0.05**
Day 5 × Session 2	1.59	0.50 – 5.05	0.436
Day 1 × Session 3	0[a]	.	.
Day 2 × Session 3	0.59	0.18 – 1.97	0.396
Day 3 × Session 3	0.79	0.24 – 2.56	0.695
Day 4 × Session 3	2.65	0.86 – 8.15	0.09

Day 5 × Session 3	0.75	0.18 – 3.06	0.686
Day 1 × Session 4	0[a]	.	.
Day 2 × Session 4	1.88	0.50 – 7.12	0.352
Day 3 × Session 4	3.54	1.07 – 11.70	0.038
Day 4 × Session 4	3.34	0.91 – 12.30	0.07
Day 5 × Session 4	4.24	1.03 – 17.47	0.045
Day 1 × Session ≥5	0[a]	.	.
Day 2 × Session ≥5	1.44	0.38 – 5.39	0.591
Day 3 × Session ≥5	0.39	0.11 – 1.32	0.129
Day 4 × Session ≥5	2.22	0.70 – 7.00	0.174
Day 5 × Session ≥5	1.55	0.41 – 5.83	0.517

a. Set to zero because this parameter is used as reference

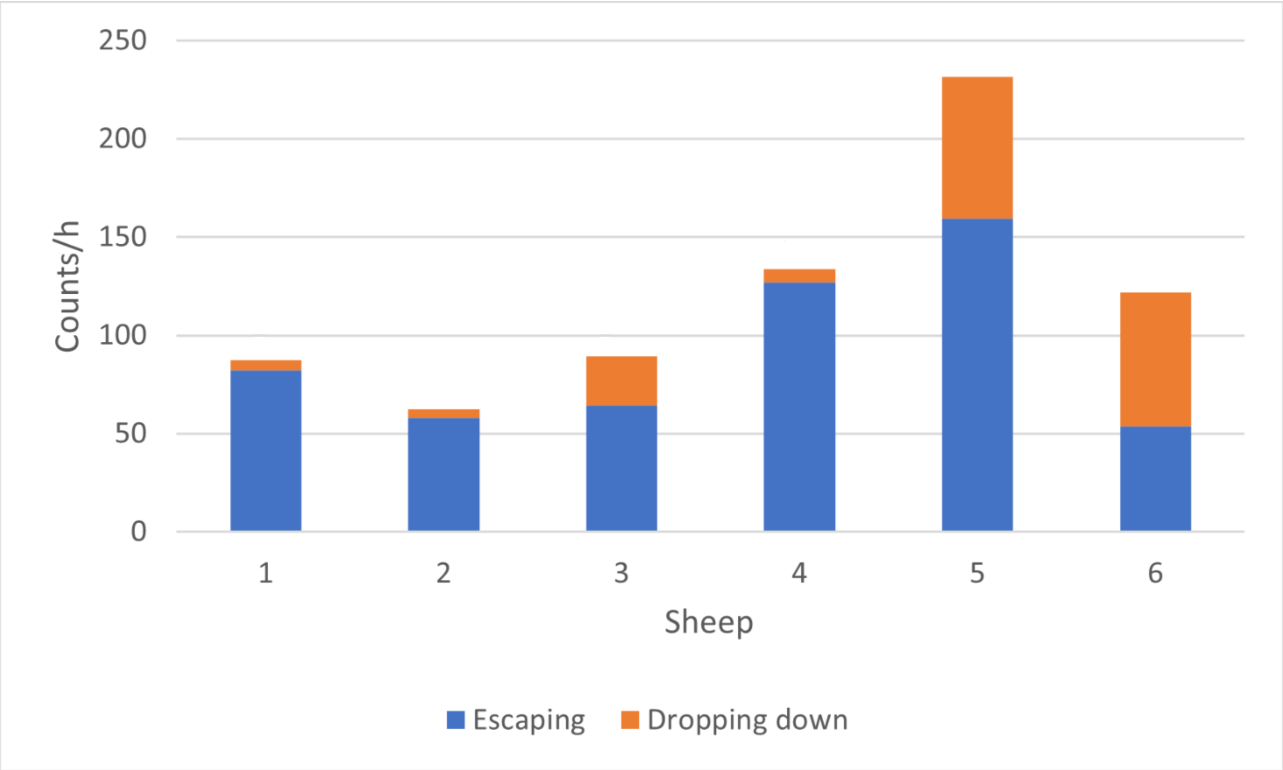

Figure 3-4. The total stress counts per teaching hour for each sheep over the total teaching period

3.4.3 Maintenance behaviour

As the only maintenance behaviour observed during the teaching period was standing behaviour, and no other maintenance behaviour was observed, it was decided to exclude the teaching period from this part of the analysis. Therefore, the maintenance behaviour was only compared before and after teaching, as shown in Figure 3-5 and used in the statistical models. Because social behaviour and walking were observed less than 10% of the time the sheep were visible, these behaviours were analysed descriptively only. An overall difference between before and after teaching was observed for lying, with more time spent lying observed after teaching on days two and three ($p < 0.05$) (Table A4-1). Differences between the periods for eating were observed on days four and five when sheep ate more after teaching compared to the period before teaching ($p < 0.05$) (Table A4-2). Overall, standing was observed less on days three and five, compared to day one ($p < 0.05$) and in all periods after teaching on all days ($p < 0.05$) (Table A4-3). There was no difference in rumination observed between days or before and after teaching (Table A4-4).

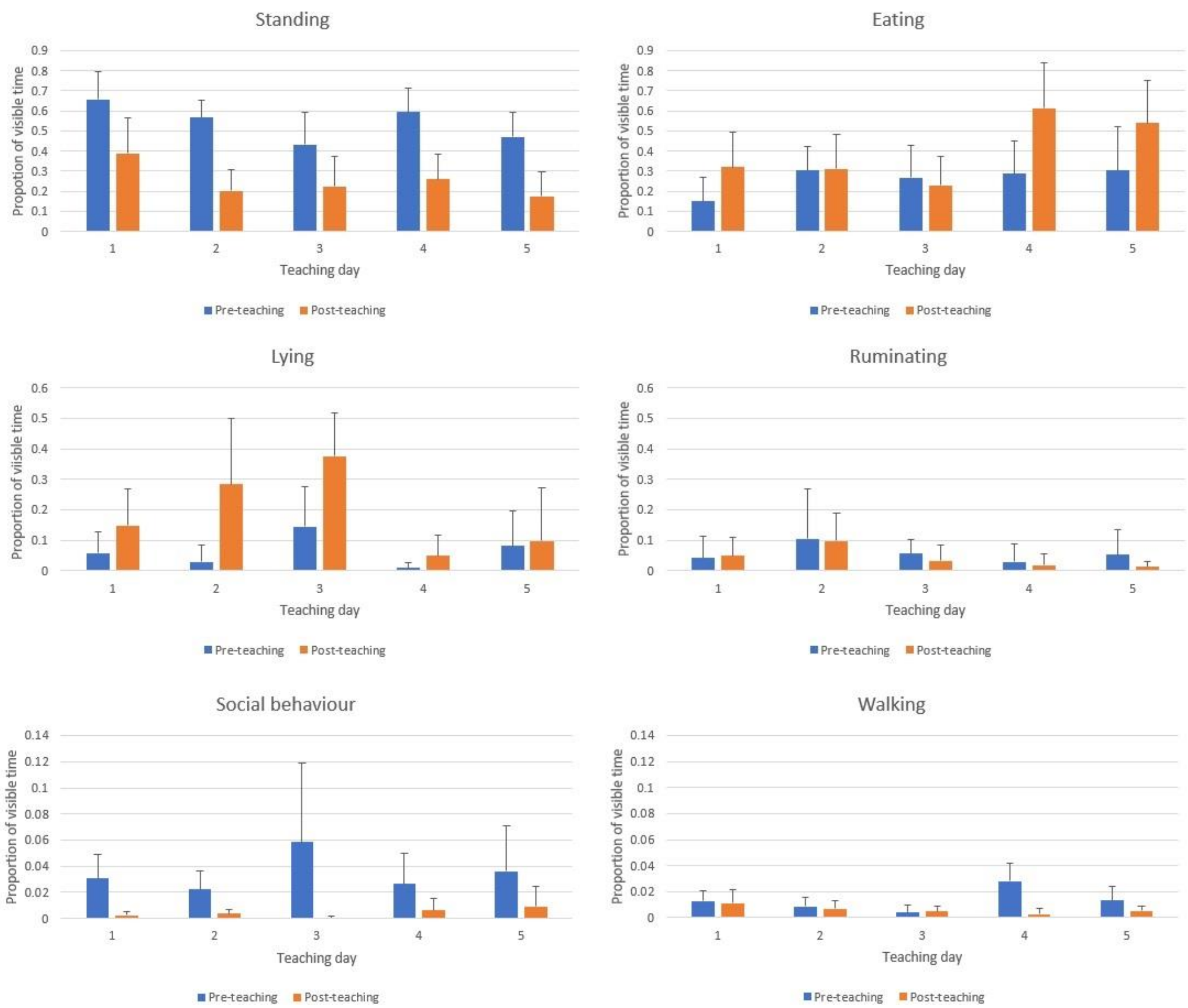

Figure 3-5: Normal maintenance behaviour of each sheep before and after teaching. Note differences on y-scales. The error bars are standard deviations

3.5 Discussion

To the authors' knowledge, this is the first study to investigate the impact of clinical teaching classes in a veterinary school on sheep behaviour. This study showed that the use of naive sheep in the clinical examination classes for the training of veterinary students induced stress behaviours, which varied between individual sheep. Habituation to clinical examination was observed after five separate classes of teaching in consecutive weeks with less stress counts observed in day four and five, even when the clinical examinations were performed by different students. Furthermore, there was an observed alteration in the demonstration of normal behaviours in the post teaching period, with a greater proportion of time spent either eating or lying down and less time standing on specific days. These findings could suggest that being used for teaching is stressful and tiring; but it is reassuring perhaps that habituation to teaching was observed here. Habituation in sheep to human stressors was also observed in the 2006 study by Erhard et al., in which sheep were approached by humans once a day for four consecutive days in a test arena where the sheep were separated from the rest of the flock to see if the flight distance to humans decreased after repeated days of testing. However, the human-animal relationship before the study began was not described. By contrast, habituation towards a stressor was not observed in a 2022 study by Atkinson et al., in which they used extensively reared two- to three-month-old Merino lambs to see if their fear in general and towards humans would reduce over time. In their study, in which several tests were performed several days a week for seven consecutive weeks, a reduction in fear of humans was not observed. One difference could be that in the clinical examination classes reported in the current study, the animal is touched by people, whereas in Atkinson's tests the lambs were only approached. Individual variation between stress responses of sheep was also observed in the study by Atkinson.

As the escape attempts were only seen when there was human contact or proximity when the sheep were in the small pen, it was assumed that these escape attempts were caused by the clinical examination and not by being confined in a small space. Social isolation may have affected the ewes although they were still able to see the other sheep. The differences in observed stress behaviour between the teaching sessions on the same day and between the days could be an indication of the effect of the individual student with differences in experience and the way they approach the animals in a clinical examination class and could therefore likely affect the behavioural responses of the sheep (Mateo, Estep and Mccann, 1991) . Also, the fact that the students knew that they were filmed could have changed their approach towards the sheep, although this factor was present on all five days. The negative correlation between the number of students in the pen and the number of observed stress counts could be related to the type of stress behaviour observed, i.e. mainly active stress behaviour and the reduced space available for this behaviour when there is more than one student in the pen. In other words, the sheep may still have been stressed but did not have the space to exhibit this behaviour.

The short observation time before and after teaching in combination with the small number of sheep will have influenced the observations seen in the maintenance behaviour. Although differences between the maintenance behaviours were observed before and after teaching, there were also differences observed between the individual sheep with respect to maintenance behaviours. Interestingly, all sheep showed increased lying and eating behaviour in the after-teaching period, which could indicate that the teaching classes are tiring for the sheep and resting afterwards is required to recover and restore energy. The absence of other maintenance behaviour apart from standing behaviour during the teaching period, could be another indicator of stress caused by teaching.

Given that this teaching event was found to be stressful for the sheep, alternatives to using live animals for veterinary education training would be indicated. Various models and simulators are widely reported in the literature (Braid, 2022) but they often lack the high fidelity needed for teaching a complex skill such as clinical exam. Also, as teaching classes could be tiring for sheep, sheep should be given enough time to recover after the class, giving them time to eat and rest. Hence, live animals are required to teach day one competencies. The utilitarian argument that the use of these animals and the stress it could induce, potentially prevents this stress in future animals because the students learned how to perform a clinical examination in the proper way and could therefore be used to justify the use of animals in this instance; however, this stress should be reduced as much as possible.

Although this study used a limited number of six sheep, had different students every week that examined the sheep and did not establish how long a recovery period needed to be, this study could still be used to inform veterinary educators: that stress in sheep could be reduced by selecting sheep that show less stress behaviour, and to build in a period of habituation of sheep before they are used in teaching classes. Given that more veterinary schools, nationally and internationally, are training greater numbers of vet students, we need to ensure the utmost standards of care for the animals we use, whilst giving the best possible training for students. Further work is necessary to find out what the time required for sheep to fully rest and recover following a teaching intervention.

3.6 Acknowledgements

We would like to thank the students who took part in this study together with the stockworkers that took care of the animals during the study. We would also like to thank Nicola Gladden for reviewing this manuscript before submission and Paul Johnson for his help and time to explain the statistics.

3.7 Author contributions

All authors contributed to the conceptualisation of the study. Sander Prins analysed the data and drafted the original manuscript supervised by Jayne Orr, Kathryn Ellis and Dorothy McKeegan. Jayne Orr, Kathryn Ellis and Dorothy McKeegan had input into revising the manuscript. All authors read and approved the final manuscript.

3.8 Conflict of Interest Statement

None of the authors has conflicts of interest to declare

3.9 Funding information

The authors received no specific funding for this work.

3.10 Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

3.11 Ethics Statement

The methods outlined in this study received ethical approval from the University of Glasgow; Animal Welfare and Ethics Committee of the School of Veterinary Medicine at the University of Glasgow (EA 52/21).

4. Discussion

4.1 General discussion

The impact on the welfare of the use of farm animals for veterinary teaching purposes is a topic that has not been investigated in much detail. The use of animals for teaching raises the ethical question of whether the potential negative impact on the welfare of the animal outweighs the potential teaching benefits the animal provides to undergraduate and postgraduate veterinary students. To address this knowledge gap, this study, divided in two parts, aimed to address aspects of this issue: The first part of this study aimed to describe the cases referred to the SCPAHFS between 2013 and 2022, based on post-mortem diagnoses and length of stay at SCPAHFS and to identify the factors that might influence whether a case stayed less than 48 hours after arrival. The second part of the study aimed to investigate the behavioural responses of sheep when used in consecutive weeks in a clinical examination teaching class, to investigate whether habituation to this specific teaching event was possible, and to investigate possible factors that could influence any stress behaviour.

4.2 Demographics of the clinical case load and potential benefits of the received teaching cases in SCPAHFS

Between 2013 and 2022, the SCPAHFS received 1206 bovine cases and 703 ovine cases, ranging in age from young to old, with various diseases within most organ systems well represented within the case load. Exposure to these clinical cases within a supportive learning environment such as a VTH can provide veterinary students with learning opportunities to help them achieve. Day One competencies, such as teamwork, acquisition of clinical skills, experience of a clinical reasoning and case responsibility to increase their confidence (Carr, Kirkwood and Petrovski, 2022). In a VTH that does not send referred cases back to the farm of origin, stress levels (in perspective of students towards the patient owner) are most likely to be lower, so a safer environment can be created for students in which to learn (Carr, Kirkwood and Petrovski, 2022). Learning from cases in a safe learning environment could benefit the future cases that students will see in practice, as the SCPAHFS environment allows for more reflection on these cases and therefore students should be better prepared for the real-life situation. The potential impact on these cases and whether it outweighs the benefits is discussed further in section 4.5.

The fact that cases do not return to the farm of origin most likely has an impact on the type of cases referred to SCPAHFS: In the years studied between 2013 and 2022, most of the referred cases were chronic and had already received treatment on the farm before being sent to SCPAHFS. This is further influenced by the requirement for animals to be fit for transport and transportation taking at least 24 hours to arrange, which means certain cases are unsuitable for admission. Therefore, the case load might not directly reflect the primary care patients that a recent graduate will deal with immediately after graduation (Smith and Walsh, 2003). The complexity of some of the cases could be a disadvantage on one hand, as the student may lose interest and confidence in their ability to manage the case. On the other hand, in a safe learning environment, as the SCPAHFS aims to be, the time and autonomy that students have within SCPAHFS will also allow them to make their own decisions, supported by guidance of the clinicians and residents. Besides this, it could also provide the veterinary student with the opportunity to explore collaboration between students, but also between the different disciplines of clinical services at the University of Glasgow. Gaining experience of consulting other disciplines could be helpful for their future careers when they need to refer cases to these disciplines and specialists (Parsell and Bligh, 2001; Smith and Walsh, 2003). The confidence and skills that students might gain from these more complex cases will depend on the guidance they receive from the clinicians who assist them in the SCPAHFS when working on these cases. If the clinician does not have much experience in certain areas, this could have a negative impact on the learning curve of the students if they do not have enough guidance in that area (Conner, Behar-Horenstein and Su, 2016). The fact that cases do not have to return to the farm of origin and all cases are euthanised at some point because of the welfare status of the animal, or because of a postmortem to reach a final diagnosis or their use in other classes, could place students and staff in moral conflict as they may feel that their actions are not for the best interest of the case and student and staff morale and engagement with the case could be impacted by the protocols within which the building operates (Kipperman, 2022; Cooney and Kipperman, 2023). Further qualitative type research would need to be carried out to investigate this.

That cases could stay for a long time within SCPAHFS as static resident case could potentially have an effect on the welfare of the animal, both negative and positive. Further investigation on the welfare of these cases needs to be carried out to understand the impact of a long stay on the welfare of the static resident.

4.3. Factors that influence duration of stay within SCPAHFS less than 48 hours after arrival

Weekday of arrival affected the outcome of duration of stay of less than 48 hours for ovine cases, with a lower odds on Friday compared to cases arriving on Monday. In addition, cases arriving on Tuesday, Wednesday and Thursday having higher odds (all days significant in bovine, only Tuesday significant for ovine cases) of staying less than 48 hours after arrival is interesting as this may suggest that the weekday of arrival influences the length of stay at the clinic. As all days were compared to Monday, the lower odds on Friday of being euthanised within 48 hours could be related to the fact that no PM's are performed on a Friday (with the PM room being reserved for emergency diagnostic cases) hence, cases are euthanised the following week so therefore their stay will be more than 48 hours within SCPAHFS. It is important to note however that animal welfare is always prioritised and if a case needed euthanasia on a Friday it would be carried out with the carcass stored until a PM was carried out on the Monday. That cases, arriving on a Tuesday, Wednesday and Thursday (for bovine) and Tuesday (only for ovine) have higher odds to stay less than 48 hours can also be explained partly in relation to the availability of the PM room; ideally the PM is carried out with a carcass in a good condition, so it might be better to euthanise the case before the weekend rather than diagnostic quality of the carcass has been affected by PM changes if the animal is euthanised during the weekend. Although it could potentially suggest that the clinical state the clinical state of cases that are received on these days is less than the other days,it is hard to prove as the majority of all cases are received on these days..

In human medicine, increased weekend mortality has been studied several times and sometimes a significant effect of the weekend on mortality has been found, as in the study by Handel et al. (2012), in which they compared mortality of emergencies arriving on weekend days with that of emergencies arriving on weekdays in Scotland between 1999 and 2009. They found that there was a significant increase of probability of death with an emergency admission at the weekend possibly caused by less availability of staff in the weekend. The situation of their study is different to SCPAHFS as there is no admission of emergencies in SCPAHFS nor admissions at the weekend. The meta-analysis by Pauls et al. (2017) which compared 97 studies investigating the mortality of human patients admitted on weekend days with those admitted on weekdays, also found a higher mortality rate for cases admitted at the weekend. The explanation given for the mortality rate is that patients admitted at that weekend received delayed diagnosis and treatment due to the lower number of staff present. One limitation of the studies of Pauls et al. and Handel et al. is that no clear differentiation was made between the diseases. A difference to these studies is that the SCPAHFS does not receive cases over the weekend, nor does it admit emergency cases, but it still has fewer staff present and no postmortem service at the weekend. This could influence the decision to euthanise the case during weekdays i.e. earlier than maybe required in order to prevent a negative impact on animal welfare at the weekend due to less staff. As the clinical status was not recorded at time of euthanasia was not investigatede, it is difficult to say whether the clinical status of animals arriving on a Friday was different from those arriving on other days. Cases arriving on a Monday staying longer than 48 hours compared to cases arriving later in the week, can be explained using similar logic as there is more time to work with them before the weekend approaches and they need to be sent for PM. The influence of the clinical status of cases arriving on Monday compared to cases arriving later in the week, has not been investigated but could potentially be affected by the weekend and their potential prolonged stay at their farm of origin. The impact of this potential prolonged waiting time could affect the survival rate before the pick-up of the case to SCPAHFS with some of them being euthanised on farm or dying before collection and this could therefore result in healthier cases arriving on a Monday with less need for them to be euthanised within 48 hours.

That bovine cases within the disease category of kidney, bladder and urinary tract had higher odds of staying less than 48 hours compared to cases within the digestive disease category is most likely a reflection of the severity of this disease category. Further investigation needs to be carried out to see if there was a correlation between the referral diagnosis, clinical diagnosis and postmortem diagnosis so that the clinical signs of a disease within this category can be better understood. Due to the nature of the categorisation of data, it could be that certain diseases within this group are responsible for the higher odds. The trend in ovine cases within the digestive disease category to have lower odds to stay less than 48 hours compared to cases within the respiratory disease category could suggest that clinical signs within this disease category are less severe than cases within the respiratory disease category. Those cases within the category of 'diagnosis not reached' on PM have lower odds to stay less than 48 hours, this could suggest that their clinical status at the time of euthanasia was not the main reason for euthanasia and that these cases may have been used for surgery teaching classes for example, rather than being euthanised for welfare or poor response to treatment reasons.

The difference between some clinicians observed in ovine cases could mean that it reflects the difference in clinical conditions/diseases of cases that has been seen by these clinicians it could also personal reasons for euthanasia and thresholds for animal welfare as they may differ from person to person (Dürnberger, 2020), but they may also reflect the difference in knowledge and experience in an animal species, as some clinicians focus more on bovine, while others focus more on small ruminants. Beliefs about the clinician's role have not been specifically studied, but Deelen et al. in 2022 and 2023 examined farm veterinarians' reflections on the end-of-life decision-making process and found that decisions around euthanasia may reflect the role the veterinarian believed they had in that specific situation. It has been investigated that there are differences between people in terms of age, gender and region of origin when it comes to how they perceive an animal's suffering, as studied by Mata et al. 2022.

The effect of age on the likelihood of staying less than 48 hours after arrival in bovine cases, with animals older than two years having a higher odds of staying less than 48 hours compared to animals younger than one year, could reflect that the older cases have more severe clinical signs than the younger cases. Another possibility is that because of difference in perception of suffering in younger animals compared to older animals, younger cases could be more likely to be treated and while for older animals the decision to euthanise is made earlier as suffering of younger animals is perceived more strongly. It could also be a reflection of the temperament of the animal as the temperament of an animal is sometimes included in the decision to euthanise and the an older more heavier animal that has an aggressive, non-cooperating behaviour is more likely to be euthanised within SCPAHFS compared to a younger animal. Further research is required to understand the relation between the age and staying less than 48 hours.

Although the travel distance and travel time for ovine cases seemed to have a trend towards staying less than 48 hours after arrival this was not observed in the final model. Most studies that found that a long distance and a long travel time could impact animal welfare investigated longer transport and longer travel times (650 km or more than twelve hours) than our study (Minka and Ayo, 2012, 2013; Alam et al., 2018). This contrasts with our study, where the median distance was 70 km and journey time was 60 minutes. Apart from the short distances between the farms of origin of most cases and SCPAHFS and the fact that no effects of transport could be detected when a case stays less or longer than 48 hours, this could also mean that recovery from the effects of transport occurs once the case arrives at SCPAHFS. It is reassuring for the ongoing activity of the VTH that transport does not seem to be detrimental to animal outcome.

The effect of sex in ovine cases to stay less than 48 hours is interesting, but difficult to interpretate because the significant category was the category of male case and the cases of unknown sex. More investigation is needed to identify the unknown sex cases and see if these are also male cases or more female cases. It could be there is a relation between the diseases that these submitted male cases had but this need to be investigated further.

The missing data, especially in relation to the PM dates, but also in relation to the sex is something that needs to be investigated but also improved. Part of the recording deficiency lies in the fact that the Excel spreadsheet used for this study is a separate database that does not have a connection with the patient record system; SCPAHFS started around 2018 with an electronic patient record system and before that time, the patient records were still on paper. In the time of paper records, SCPAHFS created an Excel datafile in which case details were recorded, and this system continues. But having multiple systems besides each other creates difficulties with keeping the records up to date. Further investigation of whether the electronic patient record system is capable of having the same record capability as the Excel file is needed together with working towards the use of onlyas record system. Alternatively, other electronic patient recording systems could be considered; however, the school is bound to using the same system across all hospital areas so it would be very difficult to unilaterally change this. Streamlining the patient recording would be a desired aim which could also more easily capture when cases are used for teaching classes etc.

Overall this part of the study showed that the weekday of arrival seem to influence the stay less than 48 hours in SCPAHFS, that cases within the kidney, bladder and urinary tract disease category have higher odds to stay less than 48 hours for bovine cases, that some clinicians influence the stay less than 48 hours for ovine cases. This could raise the question of whether prolonging the life of these cases when they are transported to SCPAHFS might not be too detrimental to the quality of life of these animals, even though these cases could serve as a learning opportunity for students. In order to see if these animals can be prevented from being transported to SCPAHFS, it would be good to record the clinical status before transport to know if some clinical parameters could indicate a severe status of the animal and with that if this animal can be prevented from being transported to SCPAHFS. In relation tothat more research in relation to the disease, referral diagnosis, and decision around euthanasia is necessary to see if there is a correlation between referral diagnosis and postmortem diagnosis. Not included in this study is the relationship between the length of stay in the SCPAHFS and the referring veterinarian. Although all veterinarians are able to determine whether an animal is stable enough for transport, it would be good to investigate this factor as well.

4.4. The impact of a specific teaching event on animal welfare

The observational study on stress behaviour and normal maintenance behaviour of naïve sheep before, during and after the clinical examination classes revealed that habituation to the clinical examination classes is possible, that the number of people and the individual sheep has an influence on whether a certain behaviour is shown and that maintenance behaviour changes after being used for teaching.

Habituation to a particular stressor is not uncommon in sheep, several studies have shown that habituation to a stressor is possible: In a study on the effect of mood towards a negative-positive stimulus pair, Raoult et al. (2019) found that habituation to the positive stimulus occurred in non-habituated sheep compared to the habituated sheep, although this effect was less for the negative stimulus. Erhard et al. (2006) found that habituation to the human approach is also possible without positive reinforcement. Differences between individual sheep in the expression of specific stress behaviour towards a particular stressor has been observed previously and may depend on several factors such as sex, experience with the stressor and rearing conditions (Mateo, Estep and Mccann, 1991a; Romeyer and Bouissou, 1992; Viérin and Bouissou, 2003), but differences in personality traits such as reactivity or calmness could also explain the differences (Marino and Merskin, 2019; Miranda-de la Lama et al., 2019).

In the current study, the decrease in expressed stress behaviour as the number of weeks of the class increased could indicate that being used in clinical examination classes was perceived as less stressful in the last day of the class compared to the first day. Another indication of the perception of less stress could be that lying behaviour was more pronounced after the class on the first day than on the last two days, which may suggest more rest was required to recover. Although other factors, such as personality, could also influence the expression of maintenance behaviour, the reduction in lying behaviour could be a further indication that the perception of being used for teaching is less stressful as the sheep become more accustomed to it.

The influence of people on the sheep when they exhibit a certain behaviour is noted in other studies (McLennan and Mahmoud, 2019; McLennan et al., 2019). McLennan (2019) observed in sheep with foot rot that the sheep showed pain behaviour when they were in a friendly, calm flock, but that this behaviour was not shown when a predator (e.g. a human) was present. When the presence of a predator was observed by the sheep, they showed no pain behaviour and tried to hide their lameness from the predator. Compared to the sheep used in clinical classes the presence of more than one person could mean that there are too many predators nearby hence the sheep chose not to exhibit certain behaviors. In addition, this physical space taken up by two students in the pen, along with the sheep could mean that sheep did not physically have the space to exhibit normal behavior.

The findings that sheep showed habituation but appeared to be tiring after being used after clinical examination classes could mean that there should be recommendations on the use of animals used for teaching and the resting period after been used for teaching. Also habituation towards clinical examination before they are used in classes, should be promoted. The individual differences in the expression and type of stress behaviour gives the opportunity to select and test animals of their behaviour before using them in teaching classes; although a calm temperament of an animal is not always a model of what a student will see in practice, it provides the student at least the opportunity to don't have to stress while learning how to perform the clinical examination.

4.5. Weighing up the costs of animal welfare against the benefit to veterinary student learning

As there are two types of animals used for teaching purposes in the SCPAHFS, the 'active' (mainly for final year) and the 'static' animals (mainly for younger years), the impact of the different teaching types, or use of animals is different for both types of animals: for the active cases these include the disease itself, the transport to the SCPAHFS, the adaptation to the new environment, handling, diagnostic interventions and treatments by stock people, students and clinicians. All of these actions could have an impact on the welfare of the animal. However, the advantage of using these animals for teaching purposes is that students can achieve multiple learning objectives in a safe learning environment but measuring the benefits of this case exposure can be difficult to explicitly measure.

Although it is difficult to measure the teaching benefits of cases and to put a specific time point on when these benefits have been achieved, this study found few clear factors that were associated with a short duration of stay. The effects of adaptation to the new environment, stockperson and students' interactions for example were not measured in this study. If all known factors are considered equal along with teaching benefit, it could be said that in some of the cases arriving on Tuesday it is questionable if their short length of stay could provide enough teaching benefit to outweigh the negative impact, especially the bovine cases within the kidney, bladder and urinary tract disease category. Further investigation would be needed to ascertain the teaching value of these cases and to evaluate if this teaching benefit can be acquired in other ways than transporting the animal to SCPAHFS, perhaps through performing farm visits to these cases. . In addition to thatI further research is needed to identify the factors of teaching benefit; for example duration of exposure to an animal, actions performed, time of discussion about the case and the effect of the exposure. It could therefore also help to specify the cases necessary to obtain this benefit.

A static case has potential more impact of teaching on their welfare coming from the repetitive nature of routine weekly classes, handling of these animals by inexperienced veterinary students and the longer periods of housing in the VTH. The advantage of using these animals for teaching purposes is that the students can learn clinical examination clinical skills using a normal animal within a safe learning environment. It was found that although the teaching event was perceived as stressful and potentially tiring for the sheep, familiarisation with the teaching event took place over time. This could mean that the impact on their welfare when being used for teaching does not outweigh the benefits of teaching for the students if the animals are habituated for these teaching events. If naïve animals are used in teaching events, these sessions could have too strong an impact on the welfare of these animals.

For example, if a sheep or beef cow were to become a static resident, the fact that it may have been reared outdoors could make it less suitable for residence in the SCPAHFS as there is no access to pasture within this building.

4.6 Alternatives to the teaching provided in SCPAHFS

To reduce the number of sheep used for teaching purposes, some of these clinical teaching classes could also be carried out on a commercial or university farm rather than at SCPAHFS. Potential benefits could be that as there are a greater number of sheep available, individual animals are used less and have more recovery time between their use in clinical examination classes. This format of class has the additional benefit that the clinical examination is carried out in the practical environment that students will work in following graduation. The teaching environment could also be a potential negative point however, as the environment with the farmer could potentially be more stressful for the students and therefore less suitable for teaching purposes as it could provide less of a safe environment. If every time new, naïve sheep are used on a farm it could also result in the sheep not habituating towards the clinical examination, so this could have more of a negative impact on these sheep compared to using sheep that are used to the clinical examination.

The use of video material or simulations in addition to the clinical examination could prepare the students even better for the clinical examination and make it less stressful for the sheep. It may also give students more time to practice the exam before performing it on a live animal. The effect of preparation through simulators on the stress on animals has been already investigated as has been discussed earlier. The effect on students is also investigated; Nagel et al. in 2015, investigated the effect of simulator training on the stress levels of students before rectal examination of horsed by comparing simulator prepared students with non-simulator prepared students and used for that heart rate variability and cortisol saliva levels. They found that the initial stress level is the same during the first attempt but that simulator prepared students had significantly lower stress levels during the second and further attempts. Although this study investigated the effect of preparation before rectal examination classes and not clinical examination classes the effect of preparation method needs to be further investigated to see if it can reduce the stress of students and of sheep.

Rather than using a VTH for case exposure and animal handling, students could be placed in partner veterinary practices to gain first opinion case exposure in a real-life veterinary environment. Although this does not completely rule out the need for animals for teaching as the RCVS requires that students are competent in animal handling before any EMS placements (RCVS, 2024) The only question is whether all the competencies can be acquired in a real-world setting. Perhaps some of the skills require a safe teaching environment to train students in these skills so that they can later practice them in the 'real' practical environment; for example, case responsibility is a skill that is better acquired in a regulated environment. The willingness of the animal owner to allow students to work on their animals is not always given, which combined with time pressures in a commercial clinical environment could reduce the learning opportunities for the students. In a practice setting, the opportunity for case diagnostics and follow up with a PM is not always possible, which could reduce the potential learning benefit for students in this type of environment.

4.7 Limitations of these studies

When analysing the factors that could influence whether a case remains in the SCPAHFS for less than 48 hours, the clinical appearance of the animal or the specific reasons for euthanasia were not considered. This could have provided more information about the specific reason for euthanasia, whereas only the recorded post-mortem diagnosis was used. The comparison between the clinical diagnosis and the post-mortem diagnosis could provide more information about the condition of the animal before euthanasia and thus possibly provide a better explanation for the differences between the diseases. The unknown waiting time between the referring vet making contact with SCPAHFS and the animal arriving at the SCPAHFS could affect the clinical condition of the animal and thus influence the length of stay at the SCPAHFS in positive or negative way. The unknown actual distance and travelling time, and therefore the use of the calculated distance and travelling time, may have reduced the actual travelling distance and time when multiple cases were collected on the same day, hence these factors may have been underestimated and may be significant. Because of the retrospective nature of this study, only historical data was used which meant some data were missing which could have had an impact on the outcome of this study. Furthermore, the categorisation of the diseases means individual diseases were not investigated and, within a category, there could be a wide variation of disease severity which could impact the outcome of stay. Using a stay of less than 48 hours as a proxy for measuring animal welfare outcome could also be criticised and in future work, a more objective measure of animal welfare should be used; such as a combination of indicators that reflects both negative and positive welfare (Browning, 2022), but also a Qualitative Behavioural Assessment could be used to assess the welfare of the animals.

In the second part of the study, only a behavioural assessment was used to determine whether the sheep experienced stress. As the second part of the study found that the number of people near the sheep showed a negative correlation with the number of stress behaviours displayed, this could mean that a sheep could perceive stress without displaying a specific stress behaviour. Therefore, it would have been useful to use other methods of stress assessment before, during and after the teaching events, such as heart rate or heart rate variability, to improve the outcome of the study. The use of a single observer for the behavioural assessment could have led to a bias in the behavioural observations and thus influenced the result socomparison between several observers could have improved the outcome of the study. The limited number of sheep could have led to over interpretation of these results, therefore the research needs to be repeated with more sheep to see if the same results are achieved. Because the positioning of the camera did not cover the whole pen, potential stress behaviour could have been missed when sheep were out of camera shot.

4.8 Further Research

The first and second parts of the study had interesting results that can be followed up with further research: In the first part of the study, the effect of the day of the week of arrival could be further investigated to ascertain if there is an association between the weekday of arrival and specific diseases. Including a comparison between the clinical and post-mortem diagnosis could increase the understanding, as the post-mortem diagnosis does not always reflect the clinical condition of the animal at the time of euthanasia. Waiting time between phone call from the referring vet and case collection is a factor that may affect length of stay in SCPAHFS and needs to be considered in further research It would also be interesting to delve into the clinician

effect further to see if there is a difference between the clinicians looking into the effect of different specialist colleges/interest in species (European College of Bovine Health Management and European College of Small Ruminant Health Management) or for example between age, gender, years of work experience within SCPAHFS and to find out how they view their role in relation to euthanasia when instructing students.
It would be interesting to repeat this study in other VTHs, where cases do not return to the farm of origin, to see if they have the same results on the factors that might influence whether animals are euthanised within 48 hours of arrival or not, and what measures they have taken to prevent that these cases are being send in.
The research on the effects of specific teaching events on animal welfare needs to be followed up in other species within the SCPAHFS and repeated using additional methods of stress assessment and an additional observer to compare behavioural assessment results. The time between two different teaching classes also needs to be investigated to see if this time impacts the amount of stress during the teaching classes and their recovery time afterwards. Further research on the recovery time of the animals used animals after teaching is suggested, especially if the different lengths of teaching classes do impact on the duration of the recovery time.

Assessment of the welfare of the animals during their stay in SCPAHFS, although not part of this study, is an important factor in determining whether the possible detrimental effects of animal welfare when animals are used for teaching are outweighed by the learning benefits gained by students (which ultimately should benefit animal welfare in the longer term). A possible way to investigate the welfare of these animals is to see if they show indicators of positive welfare and how many animals change from negative welfare indicators into positive welfare indicators during their stay within SCPAHFS.

4.9 Conclusion

This study identified that some factors influences if a case stays less or longer than 48 hours in SCPAHFS: weekday of arrival in both bovine and ovine cases, and disease of the kidney, bladder and urinary tract, and an age older than 2 years for bovine cases and for ovine cases the sex and some clinicians. It could therefore suggest that theses factors also influence the welfare of these animals This study showed that the use of sheep for clinical examination classes is perceived as stressful by sheep and that habituation towards clinical examination classes is possible. An additional finding that was observed was that there is individual difference in expression of stress behaviour by sheep. The observation that sheep were lying on some days more after their use in the clinical examination classes suggest that the sheep find these classes tiring and need time to recover. To understand the role of the factors that have higher odds of a stay less than 48 hours in SCPAHFS more research in these factors is necessary. For sheep being used in clinical exam classes this study suggests that sheep could be pre-selected for use in these classes (selecting those that exhibit less stress) and that time should be spent habituating sheep before being used for these classes in order to minimise stress. More research is necessary to investigate the recovery time needed after the use of teaching to provide sheep with sufficient time to recover from these classes. In general, this study suggests that the welfare of farm animals used for teaching may be affected by factors such as the day of arrival at the VTH, the underlying disease of the case, but also by the use of the animal in teaching. Further research into the role of the day of arrival (in relation to the process of arranging the collection of a case) and the clinical status of the animal at the farm of origin is needed to see if these factors can be influenced and prevent these cases being sent in. The use of animals for teaching can be improved by creating habituation towards clinical examination so that animals perceive less stress when used for teaching classes.

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Appendix 1

A1.1 intake forms

Date completed	**FARMER Patient History**			**SCPAHFS Vet completing form**		
Coronavirus - Is anyone on farm…	Currently displaying clinical signs?			Yes		No
	Had a positive test in last 14 days?			Yes		No
	Isolating as part of tracing from Corona +ve contact?			Yes		No
	Waiting for a test result?			Yes		No
Farmer Name			**Farm Name**			
Vet Name			**Practice Name**			
Species			**Breed**			
Sex			**Age**			
Tag number			**Ear tags correct**	Yes		No
BVD antigen tested if 'not negative holding'	Yes		No			
	Check individual antigen test on ScotEID website		Animal needs antigen tested OR BVD licence required before transport			
Clinical						
Primary complaint						
Duration of primary complaint						
Other presenting signs						
Previous illness in this animal (if yes please give details)	Yes		No			
Treatment given to case						
Response to treatment						
Only animal affected?	Yes		No			
If no……	Number affected		Total in group			
Temperament suitable?	Yes		No			
Non clinical						
Purpose of animal on farm	Milking Cow	Suckler cow	In calf heifer	Maiden heifer		
	Bull	Fat	Store calf	Neonatal calf		
	Tup	ewe	Ewe lamb for breeding	Cull ewe/tup		
	Fat lamb	Store lamb	Other			
BREEDING FEMALES ONLY						
Pregnancy status	Pregnant	Served not confirmed pregnant		Non pregnant		
Date of service		**Expected calving date**				
Date of last calving or						

lambing						
Lactational status.	Milking		If milking, yield?			
	Dry		If dry, DCT administered?			
Husbandry						
Where is the animal currently kept	At Grass		Housed			
	Date turned out		Date housed			
	Hill		Upland		Lowland	
Further grazing info						
Current feeding (tick more than one if req)	Grass		Grass Silage		Maize silage	
	Straw		Conc			
	Ad lib		Restricted		TMR	
	Mothers Milk		Artificial milk		Vol of milk per day	
Recent changes in feeding e.g. weaning	Yes		No		Date of change	
	Details of change					
Parasitology						
Date last treated for worms		Product Used				
Date last treated for fluke		Product Used				
Any other relevant information?						

Figure A1-1. Farmer history form

Date Completed/reviewed	FARMER HERD/FLOCK	SCPAHFS Vet

General			
Farmer Name			
Address			
Post Code		Phone number	
Name of Vet		Practice	
Farm CPH number	/ /		
Farm type	Beef suckler commercial ☐ Beef suckler pedigree ☐ Beef fattening ☐ Dairy ☐ Heifer rearing ☐ Total number of BREEDING cattle on farm (total if fattening) _______________ Sheep commercial ☐ Sheep pedigree ☐ Sheep fat lambs ☐ Total number of BREEDING sheep on farm _______________ Other ____________________________________		
Other enterprises on Farm	Beef ☐ Dairy ☐ Sheep ☐ Pigs ☐ Poultry ☐ Other ☐		
Biosecurity status – Open = ANY animals bought in (including bulls) If open date animals last entered holding	Open ☐ Closed ☐ Date last animal entered / /		
Disease Status			
BVD Disease status (cattle only)	Negative ☐ Not Negative ☐ Not known ☐		
BVD herd status confirmed on ScotEID (cattle only)	Yes ☐ No ☐	BVD testing method (cattle only)	Tag testing ☐ Screen test ☐ Other ☐
Health Scheme member, if yes what diseases accredited for	Yes ☐ No ☐ Diseases ____________________________		
Other disease status (tick if present or previously diagnosed)	Johnes ☐ Lepto ☐ IBR ☐ OPA ☐ None ☐ Other diseases ______________________________________		
Routine Treatments			
Vaccines routinely used on farm	BVD ☐ Leptospirosis ☐ Rotavirus/Coronavirus ☐ Salmonella ☐ Clostrdial disease ☐ (please specify) ____________________________ Respiratory Disease ☐ (please specify) ___________________________ Other ☐ (please specify) ____ No vaccine used ☐		

<table>
<tr><td rowspan="6">Endectocide routinely used on farm</td><td>Age Group of animal</td><td>Product used</td><td>When admin</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td colspan="4">Mineral Supplementation</td></tr>
<tr><td>Do you use any mineral supplementation – if yes which method</td><td colspan="3">Yes ☐ No ☐
Bolus ☐ Lick ☐ Injection ☐ Drench ☐ Top dressing feeding ☐</td></tr>
<tr><td>Is the farm known to be deficient in any minerals – If yes which mineral</td><td colspan="3">Yes ☐ No ☐
Copper ☐ Cobalt ☐ Selenium/Vit E ☐ Iodine ☐ Magnesium ☐
Calcium ☐ Other ______________________</td></tr>
<tr><td>Any Other significant information in relation to herd or flock</td><td colspan="3"></td></tr>
</table>

Figure A1-2. Farmer Herd/Flock form

Date completed	VET PATIENT HISTORY		SCPAHFS Vet
Vet Name		Phone number	
Practice Name and Address			
Farmer Name		Farm name	
Species		Breed	
Sex		Age	
Tag number			
Initial complaint			
Specific clinical signs			
Diagnosis if reached			
General Condition			
Have any lab test been performed	Yes ☐ No ☐	If yes give details	
Date last seen by vet	/ /	Was it fit for transport	Yes ☐ No ☐
Was it previously examined by vet?		Significant findings	
Treatment given to animal			
Response to treatment			
How urgent is the case	☐ High (collect within 4 days)	☐ Medium (collect 5-10 days)	☐ Low (Collect > 10 days)
Is temperament suitable for a teaching facility	Yes ☐ No ☐		
Does farmer have a herd or flock plan under regular review with practice	Yes ☐ No ☐	Are there any ongoing herd/flock health issues (if yes please give details below)	Yes ☐ No ☐
Herd/flock health issues			
Any other comments			

Figure A1-3. Vet Patient form

Case priority (circle)	High	Medium	Low
Date spoken to farmer			
Farmer Name			
Farm Address (including post code)			
Telephone number (Mobile and landline)			
Species			
Breed			
Age			
Clinical signs/diagnosis			
Specific transport instructions e.g. needs deep straw bed			
BVD licence needed (circle)	Yes (attach to email or send once received)	No	
Coronavirus questions asked	Yes	No	
Collection safe in terms of Coronavirus	Yes	No	
Any other instructions or information			

Figure A1-4. Case collection form

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FARM ANIMAL CLINICAL EXAM FORM

OBSERVATIONS								
Ear Tag		Breed			Weight			
Sex	Male		Neutered Male		Female		Age	
Demeanour	BAR		QAR		Dull			
Gait	Normal		Abnormal					
	comments							
Posture	Standing		Sternal		Lateral			
Lameness Observed	Yes		No		Comments			
Respiratory Rate	No of breaths/minute							
Respiratory Character	Normal		Hypernoea		Dyspnoea			
Rumination observed	Yes		No		Comments			
Eating observed	Yes		No					
Coughing observed	Yes		No					
Diarrhoea observed	Yes		No					
Faecal staining observed	Yes		No					
Oedema Observed	Yes		No					
Skin/wool/hair	Normal		Alopecia					
	Ring worm		Lice					
Any other observation/comments								

BACK END										
Temperature *C										
Abdominal symmetry	Normal		Left dorsal enlargement							
	Right dorsal enlargement		Left ventral enlargement							
	Right ventral enlargement									
Pulse character	Strong		Thready							
Pulse rate	beats/minute									
Pulse regularity	Regular		Regularly irregular		Irregularly irregular					
Vaginal MM	Normal		Cyanosed		Pale					
	Congested		Icteric		Petechiae					
Vulval discharge (without vaginal exam)	None detected		Mucus		Fresh blood					
	Serohaemorrhagic		Purulent		Mucopurulent					
	Brown/red									
BCS	1		2		3		4		5	
Urine stimulation	Normal		Haematuria							
	Pyuria		Dilute							
Lactation status	Lactating		Dry							
Udder and teats-Abnormalities					**Comments**					
	LF	Normal		Abnormal						
	RF	Normal		Abnormal						
	LH	Normal		Abnormal						
	RH	Normal		Abnormal						
Penis	Normal		Abnormal		**Comments**					
Prepuce	Normal		Abnormal							
Scrotum	Normal		Abnormal							
Testes	Normal		Abnormal							
Umbilicus	Normal		Purulent		Swelling					

	Pain		Heat		Hernia	
Any other comments						

HEAD								
Symmetry	Normal				Abnormal			
Muzzle	Wet		Ulceration		Dry		Crusting	
Nasal Discharge	None		Purulent		Mucus		Expistaxis	
Odour of breath	Normal		Haliotosis		Ketotic		Ammonia	
Submandibular LN	**LEFT** Normal		Enlarged		**RIGHT** Normal		Enlarged	

EYES	**LEFT**				**RIGHT**			
Vision	Normal		Impaired		Normal		Impaired	
	Blind				Blind			
Discharge	None		Mucous		None		Mucous	
	Purulent				Purulent			
Cornea	Normal		Oedema		Normal		Oedema	
	Ulceration		Keratitis		Ulceration		Keratitis	
Conjunctiva	Normal		Pale		Normal		Pale	
	Icteric		Cyanosed		Icteric		Cyanosed	
	Petechiae		Chemosis		Petechiae		Chemosis	
	Growth				Growth			
Eyelid	Normal		Abnormal		Normal		Abnormal	
Globe size	Normal		Micropthalmia		Normal		Micropthalmia	
	Enlarged				Enlarged			
Globe Position	Normal		Stabismus		Normal		Stabismus	
	Exophalmus		Enophalmus		Exophalmus		Enophalmus	
Globe Movement	Normal		Nystagmus		Normal		Nystagmus	
Pupil size	Normal		Miosis		Normal		Miosis	
	Dilated				Dilated			
PLR	Present		Reduced		Present		Reduced	
	Absent				Absent			
Menace	Present		Reduced		Present		Reduced	
	Absent				Absent			

Number of adult teeth	0		2		4		6		8			
Broken mouth	Yes				No							
Gag exam performed	Yes				No							
Tongue	Normal		Swelling		Ulceration		Abnormal tone					
Hard palpate	Normal		Swelling		Ulceration		Cleft palate					
Larynx auscultation	Normal		Harsh									
Trachea auscultation	Normal		Harsh									
Tracheal pinch test	Cough		No cough									
Jugular distention	**LEFT**	Yes		No		**RIGHT**	Yes		No			
Jugular reflux test	**LEFT**	Normal		Abnormal		**RIGHT**	Normal		Abnormal			
CRT gums	Numerical field secs											
Gum palpitation	Normal		Tacky		Dry							
Skin tent	1		2		3		4		5		>5	
% Dehydration												
Any other comments												

LEFT SIDE						
Heart rate (beats min)						
Heart Auscultation	Normal		Muffled		Murmur	
Heart rhythm	Regular		Regularly		Irregularly irregular	
Lung auscultation	Normal		Wheeze			
	Crackles		No sound			
Lung percussion	Normal		Pain			
	Heart Enlarged/		Decreased resonance			
Withers test	Positive		Negative			
Rumen auscultation	Number secs between ruminal contractions					
Rumen palpitation for layers	Normal		Abnormal			
Percussion auscultation LDA	Absent		Present			
If ping splash on Ballottement	Absent		Present			
Pre-femoral lymph node	Normal		Enlarged			
Pre-scapular lymph node	Normal		Enlarged			

	LEFT FORE				LEFT HIND			
Feet	Normal		Overgrown		Normal		overgrown	
	Swollen coronary band		Other		Swollen coronary band		Other	
Joints	Normal		Hot		Normal		Hot	
	Swollen		Painful		Swollen		Painful	
	Deformed				Deformed			
Limbs	Normal		Swollen		Normal		swollen	
	Deformed				Deformed			
Foot lifted	Yes		No					

RIGHT SIDE						
Heart auscultation	Normal		Muffled		Murmur	
Heart rhythm	Regular		Regularly		Irregularly irregular	
Lung auscultation	Normal		Wheeze			
	Crackles		No sound			
Lung percussion	Normal		Pain			
	Heart enlarged		Decreased resonance			
Percussion auscultation RDA	Absent		Present			
If ping splash on Ballottement	Absent		Present			
Pre-femoral lymph node	Normal		Enlarged			
Pre-scapular lymph node	Normal		Enlarged			
Liver enlargement	Present		Absent			

	RIGHT FORE				RIGHT HIND			
Feet	Normal		Overgrown		Normal		overgrown	
	Swollen coronary band		Other		Swollen coronary band		Other	
Joints	Normal		Hot		Normal		Hot	
	Swollen		Painful		Swollen		Painful	
	Deformed				Deformed			
Limbs	Normal		Swollen		Normal		swollen	
	Deformed				Deformed			
Foot lifted	Yes		No					
Left Side/Right side comments								

RECTAL									
Evidence of Peritonitis	Absent			Local		General			
	Comments								
Rumen	Normal			Gassy		Empty		Firm	
Kidney	Normal			Enlarged				Painful	
Caecum	Not palpated					Enlarged			
Intestine	Not palpated					Enlarged			
Bladder	Not palpated			Palpated normal		Palpated enlarged			
Uterus	Not pregnant			Pregnant		Enlarged (not pregnant)			
	Comments								
Ovaries	Right	Small		Multiple small follicle		One large follicle		CL	
	Left	Small		Multiple small follicle		One large follicle		CL	
Faeces	Normal			Diarrhoea		Melena		Dry	
	None Present			Haemorrhagic		Mucoid			
Rectal ultrasound exam performed	Yes					No			

VAGINAL EXAM						
Cervix	Open (>2 fingers)			Closed (<2 fingers)		
Vagina	Normal			Tear		
	Bruise			Polyp		
Vulva	Normal			Swollen		
	Tear			Poor confirmation		
Vaginal discharge appearance	None detected		Mucus		Fresh blood	
	Mucopurulent		Purulent		Brown	
Vaginal smell	Present			Absent		
Comments						

SUMMARY	
Problem List	
Differential Diagnosis	
Plan	

4

Figure A1-5. Clinical exam form

A1.2 SOP use of animals for teaching

37. Use of animals for teaching

Status	Active
Purpose	To ensure adequate care and welfare of animals in the Galloway Building
Author	G King
Date	9/9/2015
Reviewed by	Jayne Orr
Reviewed date	2nd August 2021
Controller	Jayne Orr
Relevant personnel	Stock-workers, interns, residents, clinical academic staff
Activity area	Clinical instruction with farm animals

1.2.1 Section 1: General

1. The clinician present and conducting the specific teaching activity (this can also be an assessment activity) has ultimate responsibility for the ethics and welfare of any teaching being carried out using a live animal.

2. Teaching of students in veterinary medicine and surgery on live animals in the SCPAHFS is covered by the Veterinary Surgeons Act which allows students to work with animals under supervision from a veterinary surgeon.

For the purpose of this SOP:

Static case = an animal that is clinically normal, recovered or stabilised from previous illness/surgery. These cases receive a clinical exam only if indicated and are subject to regular body condition scoring, weighing and foot trimming in order to maintain good health and welfare.

Active case = an animal currently undergoing investigation, receiving daily clinical exams and/or treatment (if indicated)

A1.2.2 Section 2: Teaching and assessing general clinical examination (non-invasive)

3. For clinical exam practical classes and assessment (OSCE and DOPS) sessions involving **static cases**, the following guidelines should be followed (Table 1)

Table A1-1: Guidelines for use and restraint of static teaching cases in the Galloway building

	Cattle	Sheep	Pigs	Chickens
Max time restrained / separated per session	2 hours	1 hour	20 mins	15 mins
Rest period between sessions	2 hours	1 hour	20 mins	15 mins
Max sessions per day per animal	2	2	4	6
Max sessions per week	4	4	8	12
Restraint	Head yolk or crush	Triangle pen (with other sheep outside pen)	Crush, behind gate or examined 'on the move'	Held by assistant

4. For clinical exam of **active cases** (primarily sheep and cattle), the clinician and resident on duty in the clinic is responsible for deciding if an animal can be used, how long it would be appropriate for an animal to be restrained and what rest period would be required. As a guide, animals should only be restrained for 30 minutes up to a maximum of 1.5 hours (depending on the condition). They should only be used for one session per day (as they will also be examined by BVMS 5 students on Core Production Animal (PA) rotation).

5. There must always be adequate spare animals available should an animal become distressed during a teaching/OSCE/DOP session. If there are no spares, the practical aspect of the session must be abandoned.
6. Food and water must be available to animals during each clinical exam teaching/OSCE/DOPS sessions. If this is not possible for short periods (e.g. the animal is restrained in a crush) then food and water should be readily available immediately after the session.
7. We do not conduct unsupervised clinical exam revision sessions.

A1.2.3 Section 3: Procedures other than the general clinical examination

8. The vast majority of these procedures would only be taught in BVMS 5 (the exception being the rectal examination classes at Cochno, for students in the clinical phase) and will be taught on static or active cases.

9. The procedures fall into two categories

- Examination procedures that are beyond a non-invasive, general clinical examination but are only **mildly invasive**, and thus **can be done solely for teaching** purposes
- Procedures that are invasive and can only be done if there is **clinical justification** for the individual animal or group (i.e. the farm of origin)

10. The **mildly invasive** procedures that can be done for **teaching purposes only,** are shown in Table 2 below. These can be performed on static or active cases (at the discretion of the clinician and resident on duty). The table also shows how many times per day and per week the procedure can be carried out on individual cases. However, clinical judgement should always be applied.

Table A1-2: Guidelines for frequency of teaching-only examination procedures on all cases (active and static)

Task	Times/day (incl BVMS 5)	Times/week	Notes
Rectal temperature - adult bovine (only if inserted 2cm max)	16	32	If active case, Core PA BVMS5 students will carry this out once daily
Rectal Temp – Calf (< 6 months) and sheep	4	8	
Rectal examination (manual, ultrasound)	3	6 Not successive days	7 days rest if blood on glove
Vaginal exam	3	6 Not successive days	7 days rest if blood on glove
Cattle oral exam (not gag)	3	6 Not successive days	Demo by clinician only in BVMS 1 and 2
Sheep oral exam	1	2 Not successive days	
Ultrasound transcutaneous	NA Refer to table above re. standing time	4	If unhealthy, clinician and resident decide

11. The procedures that can only be done if there is **clinical justification and only in active cases,** are shown in Table 3 below. At times, BVMS 5 students (and occasional EMS students) will be asked to carry out these procedures without a clinician or resident being physically present but the students will always be under the direction of the clinician or resident on duty.

12. The procedures that students are asked to perform are dependent on their abilities and prior experience. As BVMS 5 students are in the professional phase we rely on their honesty in terms of prior experience. Whether activities are directly or indirectly supervised will be decided on a case-by-case basis, but a guide is shown below in Table 3. Students are given access to this list via the Core PA moodle page before starting BVMS 5 rotations.

13. To help staff and students, the common procedures have been divided into three supervision categories:
    i) Indirectly supervised - as instructed by the clinician or resident on duty who might not actually be in the building if the student feels comfortable to do so
    ii) Directly supervised - watched (possibly at a distance) by the clinician or resident on duty, who can give guidance if necessary but will not interfere with the procedure
    iii) Directly and actively supervised by the clinician or resident on duty who can actively help or possibly take over the procedure

NB Indirectly supervised procedures would usually take place after initially being actively supervised, i.e. once a level of competence is established. For directly supervised procedures clinicians and residents use their judgement as to when to intervene and take over a procedure from a student e.g. if a blood sample is not obtained in two attempts, or if there is obvious distress from an animal. Some animals known to be difficult or aggressive may be excluded from student contact.

Table A1-3. Procedures only to be undertaken if there is a clinical justification for active cases.

Indirectly supervised	**Directly supervised**	**Directly and actively supervised**
Clinical examination of co-operative patients*	Intra-mammary treatments	Intravenous catheter placement and fluid administration
Administration of medicines (intra-muscular and subcutaneous)	Physical examination of a fractious patient	Anaesthesia and sedation
Intravenous injections (three attempts only)	Oral examination with a gag	Positioning for radiographs
Collection of free catch urine samples	Urinary catheterisation	Disbudding/de-horning
Collection of faecal samples	Foot trimming (stock worker can supervise)	Castration
	Wound management	Euthanasia
	Oral fluid administration	Micotil injection

Collection of blood samples (Three attempts only) Suture removal Vaginal exam* Rectal exam* Ultrasound examination* Oral exam* Fine needle aspiration Milking Skin scrape and / or sellotape strip	(includes the items on the list above if student was unsure/inexperienced)	Any other surgical procedure Stitching wound (includes the items on both of the lists above if student was unsure/inexperienced)

*also appear on other list a. Procedures that can be done for teaching

A1.2.4 Section 4: Recording of teaching events

14. For active cases, all procedures carried out, whether for teaching only or based on clinical justification are recorded in Stringsoft (see SOP 6 Clinical Record Keeping in SCPAHFS).

15. For clinical exam classes and assessments involving active cases the following form (which is stored in the yellow folder at the entrance to the Galloway Building) is completed. This information is then transferred to Stringsoft by the technician. Active cases are identified by their Eartag and Stringsoft case number.

Table A1-4. Recording form of the case used for clinical exam classes

Date		Session 1	Notes	Session 2	Notes
Staff					
Time					
Case 1 (CN and complaint)					
Case 2 (CN and complaint)					
Case 3 (CN and complaint)					

16. For static cases, each case has a form in the yellow folder (see below) and each time the static animal is used, a row on the form is completed. There are separate forms for sheep and cattle.

Table A1-5. Cattle form

MANAGEMENT NUMBER			
Date	Teaching event (tick)	Duration (mins)	Notes e.g. blood on glove
	Clinical exam [ ] Rectal exam [ ] Vaginal exam [ ] Oral exam [ ] Other (specify).....................		

Table A1-6. Sheep form

TAG NUMBER			
Date	Teaching event (tick)	Duration (mins)	Notes e.g. blood on glove
	Clinical exam [ ] Oral exam [ ] Other (specify).....................		

17. In addition to the Stringsoft case number, all static animals have a short management number which is displayed via an ear tag (cattle, sheep) and spray mark (sheep only) for ease of identification.

18. Pigs and chicken teaching events are recorded directly into Stringsoft by the technician.

19. Before using an animal for teaching or assessment, staff and students should check the yellow folder to see when the animal was last used and consult the notes and table 2 above, to see if it is ok to use the animal.

20. Once per year (during the summer break), the information recorded in Stringsoft is reviewed and any adjustments in procedures are made

Appendix 2

Table A2-1. Specification of respiratory diseases diagnosed in bovine in SCPHAFS between 2013-2022.

	Main category	Additional category
Acute pneumonia	4	
Chronic pneumonia	85	
Pleuritis		2
Pneumonia	91	
Lungworm		1
Pleuritis		4
Pulmonary emphysema		1
Bronchopleuritis	1	
Laryngitis	3	
Mycoplasma pneumonia	9	
Lungworm	5	
Mycoplasma pneumonia		1
Pleuritis	4	
Lungworm		1
Pulmonary emphysema	1	
Alveolitis	1	
Aspiration pneumonia	2	
Total	206	10

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Table A2-2. Specification of digestive tract diseases diagnosed in bovine in SCPAHFS between 2013-2022.

	Main category	Additional category
Dentition/dental disease	8	
Traumatic reticulitis		1
Parasitic gastroenteritis	6	
Johne’s disease	77	
Parasitic gastroenteritis		2
Peritonitis		1
Rumen fluke		2
Vagal indigestion	2	
Ilieus	2	
Peritonitis	41	
Acidosis/ruminitis		1
Left displace abomasum		2
Abomasal ulcer		3
Rectal tear		1
Abomasal impaction	3	
Chronic enteritis	7	
Acidosis/ruminitis	5	
Peritonitis		1

Left displaced abomasum	8	
Abomasal ulcer		1
Sand impaction		1
Abomasal ulcer	10	
Peritonitis		4
Thickened illeum	4	
Increased copper liver level		1
Ulcers in mouth, oesophagus	1	
Distended rumen		1
Abomasal impaction	2	
Rectal prolaps	1	
Deformity	1	
Omentum fibrosis	1	
Right displaced abomasum	6	
Abomasal ulcer		1
Reticulitis	5	
Peritonitis		2
Atresi ani	1	
Fat necrosis	3	
Salivary gland carcinoma	1	
Rumen fluke	1	
Johne’s disease		1
Traumatic reticulitis	5	
Peritonitis		2
Cleft palate	3	
Wooden tongue	1	
Enteropathy	1	
Mesenteric torsion	3	
Oesophagus trauma	1	
Sand impaction	1	
Rectal stricture	1	
Megaoesophagus	1	
Intestinal obstruction	1	
Total	214	28

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Table A2-3. Specification of circulatory diseases cattle diagnosed in bovine in SCPAHFS between 2013-2022.

	Main category	Additional category
Endocarditis	15	
Congenital disease	1	
Ventricle septum defect	8	
Endocarditis		1
Persistent ductus arteriosus		3
Pericarditis	3	
Malformation	1	
Vena cava caudalis trombosis	4	
Cardiomyopathy	1	
Persistent ductus arteriosus	1	
Ruptured chorda tendinae	2	
Hyperthrophy myocardium		1
Total	36	5

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Table A2-4. Specification of diseases in the blood producing organs diagnosed in bovine in SCPAHFS between 2013-2022.

Main category	Number
Haematoma	1
Lymphadenopathy	1
Protophyria	1
Thymic lymphosarcoma	6
Lymphoma	1
Sporadic Bovine Leucosis	1
Splenic abscess	1
Foreign body spleen	2
Mycoplasma. wyeonni	1
Total	15

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Table A2-5. Specification of skin diseases diagnosed in bovine in SCPAHFS between 2013-2022.

Main category	Number
Photosensitivity	4
Papillomatosis	2
Granuloma	1
Hyperkeratosis	1
Umbilical fibrosis	1
Hypotrichosis	2
Abscess	2
Melanoma	1
Total	14

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Table A2-6. Specification of liver diseases diagnosed in cattle in SCPAHFS between 2013-2022.

Main category	Number
Liver fluke	5
Bile stone	1
Liver abscess	3
Hepatitis	1
Cholangitis	1
Liver laesion	1
Liver hyperthrophy	1
Heppatic lipidosis	1
Total	14

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Table A2-7. Specification of kidney and bladder diseases diagnosed in bovine in SCPAHFS between 2013-2022.

	Main category	Additional category
Pyelonephritis	7	
Peritonitis		1
Urolithiasis		1
Renal amyloidosis	1	
Cystitis	1	
Pyelonephritis		1
Nephritis	1	
Cystitis		1
Urachus abscess	1	
Penis necrosis	1	
Urethra obstruction	1	
Total	13	4

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Table A2-8. Specification of eye/ear diseases diagnosed in bovine in SCPAHFS between 2013-2022.

Main category	Number
Third eyelid carcinoma	3
Cataract	4
Uveitis	1
Glaucoma	1
Microphthalmia	1
Total	10

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Table A2-9. Specification of diseases in multiple organs diagnosed in bovine in SCPAHFS between 2013-2022.

	Main category	Additional category
Acute pneumonia	1	
Hyperthrophy myocardium		1
Chronic pneumonia	18	
Dentition/dental disease		2
Navel ill		1
Arthritis/polyathritis		2
Mastitis		1
Johne's disease		1
Renal amyloidosis		3
Peritonitis		1
Pericarditis		1
Left displaced abomasum		1
Abomasal ulcer		1
Pleuritis		1
Reticulitis		1
Ascites		1
Liver lesions		1
Endocarditis	15	15
Septicaemia		4
Pneumonia		6
Ventricle septum defect		1
Liver abscess		2
Nephritis		1
Amyloidosis		1
Dentition/dental disease	1	
Osteomyelitis		1
BVD persistent infected	16	
Acute pneumonia		1
Pneumonia		5
Septicaemia	8	
Endocarditis		1
Pneumonia		1
Arthritis/polyathritis		1

Pyelonephritis		1
Acidosis/ruminitis		1
Pneumonia	34	
Endocarditis		5
Dentition/dental disease		1
BVD persistent infected		1
Septicaemia		2
Navel ill		2
Arthritis/polyathritis		2
Mastitis		1
Johnes disease		1
Liver fluke		1
Peritonitis		1
Cataract		1
Left displaced abomasum		1
Abomasal ulcer		2
Hydrocephalus		1
Alopecia anodontia		1
Thickened Illeum		1
Umbilical hernia		1
Vena cava caudalis thrombosis		2
Renal cysts		2
Nephritis		1
Distended rumen		1
Pericardial effusion		2
Encephalitis		1
Arthritis/polyathritis	10	
Endocarditis		2
Pneumonia		1
Mycoplasma pneumonia		1
Umbilical infection		3
Meningitis		1
Omphalophlebitis		2
Contracted tendons	1	
Pneumonia		1
Osteochondrosis dissecans	2	
Lungworm		1
Digital dermatitis		1
Chronic nephritis	1	
Pulmonary emphysema		1
Mastitis	2	
Pneumonia		1
Arthritis/polyathritis		1
Johne’s disease	11	
Chronic pneumonia		2
Pneumonia		3

Lungworm		2
Fracture		1
Liver fluke		2
Liver laesions		1
Ventricle septum defect	12	
Chronic pneumonia		2
Pneumonia		5
Brachygnathia		1
Scoliosis		2
Persistent ductus arteriosus		2
Lungworm	3	
Septicaemia		1
Rumen fluke		1
Photosensitivity	2	
Parasitic gastroenteritis		1
Liver lesions		1
Fracture	1	
Acidosis/ruminitis		1
Pyelonephritis	2	
Pneumonia		1
Omphalophlebitis		1
Pododermatitis	2	
Osteomyelitis		1
Liver fluke		1
Hydronephrosis	1	
Pneumonia		1
Liver fluke	5	
Johnes disease		1
Lungworm		1
Peritonitis		1
Rumen fluke		1
Toe necrosis		1
Liver abscess	2	
Abomasal ulcer		1
Foreign body duodenum		1
Peritonitis	14	
Mastitis		2
Pyelonephritis		1
Liver fluke		1
Pericarditis		1
Left displaced abomasum		1
Abomasal ulcer		1
Endometritis		1
Maligne Catharral Fever		1
Cystitis		1
Nephritis		1

Ascitis		1
Splenic abscess		1
Vulvitis		1
Third eyelid carcinoma	1	
Pneumonia		1
Traumatic reticulo pericarditis	13	
Splenic abscess		1
Pericarditis	1	
Pleuritis		1
Acidosis/ruminitis	2	
Liver fluke		1
Abomasal ulcer		1
Left displaced abomasum	5	
Chronic pneumonia		1
Pneumonia		2
Peritonitis		1
Increased copper liver level		1
Abomasal ulcer	4	
Pneumonia		1
Liver abscess		1
Peritonitis		1
Nephritis		1
Endometritis	1	
Nephritis		1
Maligne Catharral Fever	10	
Persisten foramen ovale	1	
Enteritis		1
Neoplastic kidneys	1	
Pneumonia		1
Ruptured urethra	1	
Pneumonia		1
Umbilical hernia	2	
Lungworm		1
Urachus abscess		1
Abomasal impaction	1	
Pneumonia		1
Cardiac malformation	1	
Pericardial effusion		1
Vena cava caudalis thrombosis	2	
Pneumonia		1
Liver abscess		1
Atresi ani	1	
Thickened Illeum		1
Fat necrosis	2	
Ascitis		2
Pyometra	1	

Pyelonephritis		1
Traumatic reticulitis	1	
Pneumonia		1
Cleft palate	1	
Ventricle septum defect		1
Cardiomyopathy	1	
Liver fluke		1
Tail necrosis	1	
Hepatic lipidosis		1
Hydrops	1	
Udder dermatitis	1	
Chronic mastitis		1
Liver fluke	2	
Johnes		2
Omphalophlebitis	1	
Septicaemia		1
Ascites	1	
Pericardial effusion		1
Dilatation of oesophagus	1	
Aspiration pneumonia		1
Amyloidosis	2	
Acute pneumonia		1
Aspergillus pneumonia	1	
Mastitis		1
Urachus abscess	1	
Umbilical hernia		1
Parasitic gastroenteritis	1	
Chronic nephritis		1
Abomasitis	1	
Ascites		1
Pleural effusion	1	
Ascites		1
Rectal-uterine fistula	1	
Total	232	207

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Table A2-10. Specification of endocrinological diseases diagnosed in bovine in SCPAHFS between 2013-2022

Main category	Number
Pituitarry gland cyst	1
Total	1

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Table A2-11. Specification of reproductive diseases diagnosed in bovine in SCPAHFS between 2013-2022.

	Main category	Additional category
Uterine torsion	2	
Peritonitis		1
Pseudohermaphroditis	1	
Endometritis	4	
Ovarian neoplasia	1	
Free martin	7	
Neoplasia	1	
Pyometra	1	
Hypospadia	1	
Total	18	1

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Table A2-12. Specification of neurological diseases diagnosed in bovine in SCPAHFS between 2013-2022.

	Main category	Additional category
Meningocele	1	
Listeriosis	3	
Brain abscess	4	
Hydrocephalus	1	
Spina bifida	1	
Meningitis	1	
Septicaemia		1
Spinal abscess	2	
Cerebellar medulloblastoma	1	
Cerebellar hypoplasia	2	
Nerve paralysis	1	
Wallerian degeneration	1	
Total	18	1

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Table A2-13. Specification of mammary disease diagnosed in bovine in SCPAHFS between 2013-2022.

Main category	Number
Chronic mastitis	1
Mastitis	3
Precocious mammary development	1
Teat necrosis	1
Total	6

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Table A2-14. Specification of musculoskeletal diseases diagnosed in bovine in SCPAHFS between 2013-2022.

	Main category	Additional category
Congenital	1	
Arthritis/polyarthritis	22	
Osteochondrosis dissecans		1
Seroma	2	
Contracted tendons	4	
Osteochondrosis dissecans	25	
Spastic paresis		2
Laminitis		1
Growth plate necrosis	2	
Degenerative joint disease	2	
Joint fibrosis	2	
Phlegmona	1	
Kyphosis	1	
Fracture	11	
Osteomyelitis	4	
Overgrown claw	1	
Umbilical infection	3	
Spastic paresis	14	
Temporomandibular joint dysplasia	1	
Neck muscle necrosis	2	
Laminitis	2	
Chondrodysplasia	4	
Malformation	6	
Umbilical hernia	4	
Neoplasia	1	
Tenosinovitis	1	
Chondritits	1	
Muscle athrophy	2	
Lumpy jaw	2	
Scoliosis	1	
Atrogryposis	1	
Ankylosis	1	
Abscess	1	
Patella luxation	1	
Chronic hip displacement	1	
Total	127	4

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Table A2-15. Specification of respiratory diseases diagnosed in ovine in SCPHAFS between 2013-2022.

	Main category	Additional category
Acute Pneumonia	3	
Chronic Pneumonia	17	
Muelleris capillaris		1
Ovine Pulmonary Adenocarcinoma	80	
Pneumonia		5
Lungworm		1
Pneumonia	20	
Pleuritis		2
Bronchopleuritis	1	
Laryngitis	8	
Mycoplasma pneumonia	1	
Lungworm	8	
Pneumonia		1
Maedi Visna	1	
Pleuritis	2	
Muelleris capillaris	1	
Aspiration pneumonia	1	
Total	143	10

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Table A2-16. Specification of digestive tract diseases diagnosed in ovine in SCPAHFS between 2013-2022.

	Main category	Additional category
Dentition/dental disease	41	
Parasitic gastroenteritis		1
Abomasal ulcer		2
Parasitic gastroenteritis	14	
Johnes disease		1
Johnes disease	24	
Peritonitis	1	
Abomasal impaction	1	
Chronic enteritis	2	
Neoplasia	4	
Rectal prolapse	1	
Atresi Ani	1	
Rumen fluke	1	
Total	90	4

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Table A2-17. Specification of circulatory diseases diagnosed in ovine in SCPAHFS between 2013-2022.

Main category	Number
Endocarditis	2
Cardiomyopathy	1
Total	3

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Table A2-18. Specification of diseases in the blood producing organs diagnosed in ovine in SCPAHFS between 2013-2022.

Main category	Number
Lymphadenopathy	1
Caseous Lymphadenitis	2
Lymphoma	2
Total	5

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Table A2-19. Specification of skin diseases diagnosed in ovine in SCPAHFS between 2013-2022.

Main category	Number
Contagious ecthyma	3
Photosensitivity	3
Pododermatitis	1
Granuloma	1
Toe abscess	1
Footrot	2
Contagious Ovine Digital Dermatitis	2
Fly strike	1
Total	14

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Table A2-20. Specification of liver diseases diagnosed in ovine in SCPAHFS between 2013-2022.

Main catgeory	Number
Liver fluke	15
Hepatitis	1
Total	16

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Table A2-21. Specification of kidney, bladder diseases diagnosed in ovine in SCPAHFS between 2013-2022.

Main category	Number
Chronic nephritis	1
Pyelonephritis	1
Hydronephritis	1
Total	3

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Table A2-22. Specification of eye/ear diseases diagnosed in ovine in SCPAHFS between 2013-2022.

Main category	Number
Third eyelid carcinoma	1
Retrobulbair abscess	1
Keratoconjunctivitis	1
Total	3

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Table A2-23. Specification of diseases in multiple organs diagnosed in ovine in SCPAHFS between 2013-2022.

	Main category	Additional category
Chronic pneumonia	3	
Parasitic gastroenteritis		1
Pericarditis		1
Hepatitis		1
Ovine Pulmonary Adenocarcinoma	8	
Dentition/dental disease		3
Johnes		2
Footrot		1
Mammary abscess		1
Hypertrophy myocardium		1
Endocarditis	2	
Arthritis/polyarthritis		1
Mastitis		1
Dentition/dental disease	12	
Ovine Pulmonary Adenocarcinoma		1
Parasitic gastroenteritis		3
Mastitis		1
Lungworm		1
Osteomyelitis		2
Liver fluke		2
Liver lesions		2
Parasitic gastroenteritis	3	
Pneumonia		1
Se/Co deficiency		2

Septicaemia	2	
Chronic mastitis		1
Nephritis		1
Pneumonia	13	
Arthritis/polyarthritis		1
Liver fluke		1
Renal amyloidosis		1
Meningitis		1
Rumen fluke		2
Cholangitis		1
Dermatitis		1
Nephritis		2
Liver fluke		1
Liver lesion		1
Toe granuloma		1
Bronchopleuritis	1	
Pericarditis		1
Arthritis/polyarthritis	5	
Chronic pneumonia		1
Pneumonia		1
Contagious ecthyma		2
Spinal abscess		1
Mastitis	3	
Chronic pneumonia		1
Pneumonia		2
Johnes disease	4	
Chronic pneumonia		1
Pneumonia		1
Liver fluke		1
Ascites		1
Lungworm	1	
Ostertagia		1
Photosensitivity	3	
Parasitic gastroenteritis		2
Pneumonia		1
Liver fluke	3	
Dentition/dental disease		1
Pneumonia		1
Johnes disease		1
Brain abscess	1	
Chronic pneumonia		1
Liver abscess	1	
Splenic abcsess		1
Spinal infection	1	
Septicaemia		1
Acidosis/ruminitis	1	

Mastitis		1
Cysticercus tenuicollis	2	
Footrot	2	
Pneumonia		1
Liver fluke		1
Contagious Ovine Digital Dermatitis	1	
Pneumonia		1
Spinal abscess	1	
Pneumonia		1
Pericardial effusion	3	
Ascites		3
Bracken intoxication	3	
Total	79	74

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Table A2-24. Specification of reproductive diseases diagnosed in ovine in SCPAHFS between 2013-2022.

Main category	Number
Missing right uterine horn/deformed cervix	1
Pseudohermaphroditis	2
Endometritis	2
Neoplasia	1
Vaginal prolapse	1
Epididymitis	1
Scrotal hernia	1
Total	9

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Table A2-25. Specification of neurological diseases diagnosed in ovine in SCPAHFS between 2013-2022.

Main category	Number
Intoxication	2
Atypical scrapie	1
Meningocephalitis	2
Listeriosis	4
Brain abscess	1
Ataxia	1
Spinal infection	3
Spinal abscess	2
Nerve paralysis	1
Cerebrocortical necrosis	1
Closantel intoxicity	1
Total	19

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Table A2-26. Specification of mammary disease diagnosed in ovine in SCPAHFS between 2013-2022.

Main category	Number
Mastitis	3
Total	3

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Table A2-27. Specification of musculoskeletal diseases diagnosed in ovine in SCPAHFS between 2013-2022.

	Main category	Additional category
Abdominal hernia	3	
Navel ill	1	
Muscle atrophy		1
Arthritis/polyarthritis	31	
Maedi Visna		1
Seroma	1	
Contracted tendons	1	
Degenerative joint disease	3	
Joint fibrosis	2	
Fracture	1	
Osteomyelitis	5	
Valgus deformity	1	
Sequestrum	1	
Malformation	3	
Arthrohryposis	1	
Brachygnathia	1	
Inguinal hernia	1	
Ankylosis	2	
Abscess	1	
Chronic hyperflexion	1	
Muscle abscess	2	
C5-C6 luxation	1	
Total	63	2

Main category: diagnosis written in the Excel database. Additional category: additional PM findings were recorded within the additional category.

Appendix 3

Table A3-1. UP-values of all univariate analyses of the influence these factors on the duration less than 48 hours in SCPAHFS in bovine and ovine.

Factor	p-value bovine	p-value ovine
Month	**0.091**	**0.069**
Age	**<0.05**	**0.16**
Weekday of arrival	**<0.05**	**<0.05**
Clinician	**0.15**	**0.068**
Disease category	**<0.05**	**<0.05**
Distance to SCPHAFS	0.46	**0.056**
Time to SCPAHFS	0.46	**0.051**
Purpose farm	0.33	NA
Sex	0.21	**<0.05**
Inividual or group case	**0.15**	0.3

Table A3-2. Goodness of fit model for the factors used in the model to analyse the influence of these factors on the duration of less than 48 hours in SCPAHFS in bovine

	Df	Deviance Resid.	Df Resid.	Dev	P-value (>Chi)
Weekday of arrival	4	34.38	1049	1264,6	**<0.05**
Age	4	23.79	1045	1240,8	**<0.05**
Disease category	11	25.24	1034	1215,6	**<0.05**
Clinician	14	20.09	1020	1195,5	0,13
Month	3	6.88	1017	1188,6	0,76
Group.individual	2	3.04	1015	1185,6	0,21

Table A3-3. Goodness of fit model for the factors used in the model to analyse the influence of factors on duration of less than 48 hours in SCPAHFS in ovine

	Df	Deviance Resid.	Df Resid.	Dev	Pr (>Chi)
Weekday of arrival	4	25.53	449	496.81	**<0.05**
Sex	2	17.59	447	479.22	**<0.05**
Month	3	5.73	444	473.48	0.13
Clinician	14	19.86	433	453.62	**<0.05**
Distance to SCPAHFS	1	3.49	432	450.13	0.06
Time to SCPAHFS	1	0.053	431	450.08	0.82
Age	5	8.82	426	441.26	0.11
Disease category	10	22.91	416	418.35	**<0.05**

Table A3-4. Mean days in the clinic by main diseases category per species in the period 2013-2022. After exclusion of missing PM dates.

	Disease group	Mean	95.0% Lower CL for Mean	95.0% Upper CL for Mean	Standard Error of Mean
Bovine	Respiratory	25	18	32	4
	Digestive	30	17	42	7
	Circulation	43	7	79	18
	Blood producing organs	10	2	18	4
	Skin diseases	15	7	22	3
	Liver diseases	26	6	46	9
	Kidneys, bladder, urinary tract	8	1	16	4
	Eyes, ears	78	13	143	29
	Multiple systems involved	25	14	36	6
	Endocrinology	213	.	.	.
	Reproductive organs	71	25	118	22
	Neurology	26	11	42	7
	Mammary	12	1	24	4
	Diagnosis not reached	44	28	60	8
	Musculoskeletal	24	16	32	4
	No information	40	19	61	10
	No PM	48	11	86	17
	Other	17	4	39	8
Ovine	Respiratory	21	11	32	5
	Digestive	22	16	28	3
	Circulation	9	3	33	6
	Blood producing organs	11	5	27	6
	Skin diseases	353	216	921	263
	Liver diseases	29	13	45	8
	Kidneys, bladder, urinary tract	30	49	109	18
	Eyes, ears	22	245	289	21
	Multiple systems involved	15	10	19	2
	Reproductive organs	46	8	83	16
	Neurology	19	3	35	7
	Mammary	1	0	5	1
	Diagnosis not reached	55	0	111	28
	Musculoskeletal	12	6	18	3
	No information	82	18	146	32
	No PM	73	36	109	17
	Other	8	3	18	4

Table A3-5. mean distance and travel time to SCPAHFS by species in the period 2013-2022.

	Distance to SCPAHFS				Time to travel			
	Mean	95.0% Lower CL for Mean	95.0% Upper CL for Mean	Standard Error of Mean	Mean	95.0% Lower CL for Mean	95.0% Upper CL for Mean	Standard Error of Mean
Bovine	72.5	69.5	75.5	1.5	89.1	60.9	117.3	14.4
Ovine	47.8	45	50.7	1.4	136.9	47.6	226.1	45.4

Appendix 4

Table A4-1. Parameter estimates on proportion of lying behaviour. Bold font indicates statistical significance ($p < 0.05$)

Predictors	*Estimates*	*CI*	*p value*
Day 1	0[a]	.	.
Day 2	0.64	0.20 – 2.05	0.454
Day 3	1.32	0.41 – 4.23	0.639
Day 4	0.59	0.19 – 1.90	0.381
Day 5	0.71	0.22 – 2.26	0.558
Day 1 × Before teaching	0[a]	.	.
Day 1 × After teaching	1.84	0.58 – 5.87	0.302
Day 2 × Before teaching	0[a]	.	.
Day 2 × After teaching	4.5	1.41 – 14.31	**<0.05**
Day 3 × Before teaching	0[a]	.	.
Day 3 × After teaching	6.09	1.95 – 19.03	**<0.05**
Day 4 × Before teaching	0[a]	.	.
Day 4 × After teaching	1.35	0.42 – 4.32	0.615
Day 5 × Before teaching	0[a]	.	.
Day 5 × After teaching	1.46	0.46 – 4.69	0.521

a. Set to zero because this parameter is used as reference

Table A4-2. Parameter estimates on proportion of eating behaviour. Bold font indicates statistical significance ($p < 0.05$)

Predictors	*Estimates*	*CI*	*p value*
Day 1	0[a]	.	.
Day 2	2.15	0.78 – 5.94	0.139
Day 3	1.76	0.65 – 4.77	0.268
Day 4	1.81	0.67 – 4.94	0.245
Day 5	1.8	0.66 – 4.92	0.25
Day 1 × Before teaching	0[a]	.	.
Day 1 × After teaching	2.34	0.87 – 6.30	0.092
Day 2 × Before teaching	0[a]	.	.
Day 2 × After teaching	0.47	0.17 – 1.32	0.151
Day 3 × Before teaching	0[a]	.	.
Day 3 × After teaching	0.33	0.11 – 1.00	**<0.05**
Day 4 × Before teaching	0[a]	.	.
Day 4 × After teaching	3.89	1.50 – 10.13	**<0.05**
Day 5 × Before teaching	0[a]	.	.
Day 5 × After teaching	3.02	1.17 – 7.79	**<0.05**

a Set to zero because this parameter is used as reference

Table A4-3. Parameter estimates on proportion of standing behaviour. Bold font indicates statistical significance ($p < 0.05$)

Predictors	*Estimates*	*CI*	*p value*
Day 1	0[a]	.	.
Day 2	0.69	0.42 – 1.14	0.148
Day 3	0.39	0.24 – 0.63	**<0.05**
Day 4	0.79	0.48 – 1.29	0.338
Day 5	0.47	0.29 – 0.76	**<0.05**
Day 1 × Before teaching	0[a]	.	.
Day 1 × After teaching	0.32	0.20 – 0.52	**<0.05**
Day 2 × Before teaching	0[a]	.	.
Day 2 × After teaching	0.18	0.11 – 0.31	**<0.05**
Day 3 × Before teaching	0[a]	.	.
Day 3 × After teaching	0.38	0.23 – 0.63	**<0.05**
Day 4 × Before teaching	0[a]	.	.
Day 4 × After teaching	0.23	0.14 – 0.38	**<0.05**
Day 5 × Before teaching	0[a]	.	.
Day 5 × After teaching	0.23	0.13 – 0.39	**<0.05**

a. Set to zero because this parameter is used as reference

Table A4-4. Parameter estimates on proportion of rumination behaviour. Bold font indicates statistical significance ($p < 0.05$)

Predictors	*Estimates*	*CI*	*p value*
Day 1	0[a]	.	.
Day 2	0.87	0.28 – 2.66	0.801
Day 3	1.13	0.37 – 3.49	0.83
Day 4	0.71	0.23 – 2.18	0.548
Day 5	0.93	0.30 – 2.94	0.905
Day 1 × Before teaching	0[a]	.	.
Day 1 × After teaching	1.22	0.40 – 3.69	0.727
Day 2 × Before teaching	0[a]	.	.
Day 2 × After teaching	1.99	0.64 – 6.18	0.236
Day 3 × Before teaching	0[a]	.	.
Day 3 × After teaching	0.59	0.18 – 1.93	0.382
Day 4 × Before teaching	0[a]	.	.
Day 4 × After teaching	0.86	0.28 – 2.65	0.787
Day 5 × Before teaching	0[a]	.	.
Day 5 × After teaching	0.78	0.25 – 2.45	0.668

a. Set to zero because this parameter is used as reference