An analysis of risk factors associated with infection status across the dry period

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1 Abstract

The dry period is very important for mammary gland health, with the aim not only to cure existing intra-mammary infections (IMI) but also to prevent new IMI. Although it is known that the dry period is an important time for optimising udder health, the probability that individual cows will succumb to a new IMI, or if infected, will fail to cure an IMI is not well established. The aim of this study was to investigate whether lifetime cow data, available through routine on-farm milk recording, could be used to predict changes in IMI status across the dry period for individual cows that were i) deemed high somatic cell count (SCC) (> 199,000 cells/ml) or ii) low SCC (< 200,000 cells/ml) at the last test day prior to drying off. Milk recording data collected between September 1994 and July 2014 from 114 herds in Great Britain were used. Two 2 level random effects models were built and both cure and new IMI were used as outcome variables in separate models.

Cows with a smaller proportion of test days with a high SCC in the lactation prior to drying off, a smaller proportion of test days recording a high SCC in the lactation prior to the current, of lower parity, producing less milk prior to drying off, of lower days in milk at drying off and of lower SCC just before drying off were more likely to cure across the dry period. Dry period length had no effect on the likelihood of cure. Individual cows with a smaller proportion of test days recording a high SCC in the lactation prior to the current, of lower parity, of lower milk production at drying off and fewer days in milk at drying off were less likely to develop a new IMI. Dry period length was found to have no effect on the probability of new IMI. Model predictions showed that a high level of discrimination was possible between cows with a high and low risk of both cures and new infections across the dry period.

2 Acknowledgements

Undertaking a Masters in Veterinary Medicine (MVM) during my 3 year Residency in Dairy Herd Health and Production has been both challenging and immensely satisfying. It has introduced me to the concepts of evidence based veterinary medicine, veterinary epidemiology and statistics. This has given me a greater awareness of what we do and what don't know in our profession, how to work with the evidence we have available, appreciate the lack of certainty in many of the everyday decisions we make and our need to ensure we take an iterative approach to herd health management and the need to undertake intervention base studies in the future.

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5 Introduction

5.1 Background

Bovine mastitis is the most common and costly endemic disease that affects the UK and worldwide dairy industries (Rajala-Schultz et al. 1999; Whist & Osterås 2007; Farm Animal Welfare Council 2009). With relevance to its financial importance it has been estimated to cause annual production losses of £170 million in the UK, $150 million AUD in Australia and $2 billion USD in the USA and represents 38% of all direct costs associated with production disease (Kossaibati & Esslemont 1997; Coffey et al. 2006; Rajala-Schultz et al. 2011).

Mastitis is an extremely painful condition with cows suffering severe forms of the disease appearing to experience significant distress (Fitzpatrick et al. 1998). Previous research has highlighted a lowering of the pain threshold even in mild and moderate cases of mastitis and therefore pain is an important consequence of even perceived minor cases of mastitis (Kemp et al. 2008). The presence of pain ultimately intimates compromise of animal welfare and the Farm Animal Welfare Council (FAWC) (2012) recently highlighted the severe welfare implications of mastitis and have previously stated that the incidence of mastitis must be urgently reduced (Farm Animal Welfare Council 2009; Farm Animal Welfare Council 2012).

5.2 Aims

The purpose of this study was to investigate whether historic lifetime data, available through routine on-farm recording, could be used to explore associations between IMI status across the dry period for individual cows.

For example using SCC data to explore associations between the influence of previous history of infection as measured by SCC and other factors such as parity and milk yield on the transition of infection status prior to drying off to the first test day of the next lactation.

We wanted to carry out this analysis with the aim of creating a decision support tool/s centred on improving management of the dry period. These would be to enable farmers to understand the factors driving Cure IMI and New IMI across the dry period on their farms. This could then be used to indicate areas of focus in the previous lactation or during the dry period, which could be manipulated to optimise performance at this time.

5.3 Clinical mastitis

Mastitis is classified as 'clinical' when the inflammatory process as a result of a pathogen causes a range of signs including changes in the milk, changes in the udder and in some instances systemic effects and therefore clinical changes in an individual cow's demeanour or vital signs.

In the 1960s it was estimated to be greater than 150 cases per year (Wilson & Kingwill 1975). Studies conducted in the previous century and early 21st century indicate a range of mean incidences from 23 – 55 cases per 100 cows per year (Kossaibati et al. 1998; Berry 1998; Peeler et al. 2000; Bradley & Green 2001a; Peeler et al. 2002; Milne et al. 2000; Bradley 2002). However, only those conducted by Kossaibati et al. (1998) and Berry (1998) were on a national scale including 144 and 516 herds respectively. Both these and that conducted by Peeler and others (2000) were retrospective studies and therefore may have underestimated the number of cases due to a failure of diagnosis or record individual cases of clinical mastitis (Bradley et al. 2007). The significant decreases in clinical mastitis seen during this 40 year period could be attributable to the introduction of the Five Point Plan

created as a the result of research carried at the National Institute for Research in Dairying (NIRD) in Reading.

A recent study indicated a mean of 65 cases per 100 cows per year and 50 cases per 100 cows per year from samples collected during the study period or from historical farm data (Bradley et al. 2007). A more recent paper found a mean incidence rate of 55 cases per 100 cows per year (Hudson et al. 2012). Herds contributing to these studies may be assumed to be higher performing and more engaged in udder health management and therefore, may not be representative of the national dairy herd. In the former study it was also evident that nearly a quarter of herds had a clinical mastitis rate of greater than 100 cases per 100 cows per year (Bradley et al. 2007), which may suggest clinical mastitis incidence has increased during the last 10 years.

However, comparison between these studies is difficult due to differences within the materials and methods related to the definition and recording of clinical mastitis cases. All studies used farmer recorded data. Kossaibati et al. (1998) being recorded on farm but collated via farm, veterinary practice or consultants. Berry (1998) relied on farmer recording being collated on monthly visits by consultants with Peeler et al. (2000) and Bradley et al. (2007) mailing kits and relying on return for analysis. Hudson et al. (2012) relied on veterinary surgeons to make available farm recorded data via a bureau service, milk recording organisation or on farm system electronic system. Within these studies either the definition of mastitis was provided in guidance, according to individual on farm practice without direction, guidance is mentioned though no definitions are made clear in the study materials methods, some recorded severity of mastitis, whilst others did indirectly by making a record of whether milk signs and/or visible or palpable changes occurred in the

quarter/s. Discrepancies also existed within the lag periods used and how new index cases were recorded. This highlights the wide ranging differences and the difficulties in being clear on mastitis trends over the last 20 years at least.

Disappointingly, clinical mastitis recording is poor on UK dairy farms. This limits our ability to interpret disease patterns on farm and ultimately reverse the apparent upward trend in rates since the turn of the century (Hudson et al. 2012). Reasons for poor reporting on farm are widespread and may include lack of focus on recording health events as a whole, lack of understanding in the need to interpret not only prevalence but also incidence to manage udder health, lack of routine veterinary input, lack of appropriate software or ability to use technology on farm, competing interests and a failure to see that current levels of mastitis are to be considered normal with no way or need to manage them downwards. Furthermore, whilst there is a legal requirement to inspect milk for abnormality in the UK, with fore-milking being the foremost method; this is not universally performed. Detection of clinical cases is reliant on visual observation (including in line milk filters) and even if performed is a subjective assessment of visual changes to milk and the quarter/s e.g. inflammation. This ability to detect will also be under the influence of staff training and knowledge, labour availability and lighting (A J Bradley, Barkema, et al. 2012). These within and between farm factors must be taken into account when analysis is carried out on datasets reviewing mastitis events.

5.4 Subclinical mastitis

Subclinical mastitis can be defined by the presence of disease or pathogen within the mammary gland creating an inflammatory process, not measurable visually. Assessment can be achieved using somatic cell counting as a proxy for infection or inflammation and this

represents the predominant method for assessment. The associated increase in somatic cells is typically due to leukocytes associated with the presence of a pathogen. Somatic cell count can also vary due a wide range of factors such as milk yield, stage of lactation and diurnal variation. Others methods are utilised in the dairy industry to assess or detect the presence of infection at a subclinical level and include the California mastitis test, conductivity measurement, milk colour assessment using digital cameras and inflammatory markers such as liver enzymes e.g. lactate dehydrogenase (LDH), acute phase proteins e.g. milk amyloid A (MAA) and N-acetyl-β-D-glucosaminidase (NAGase). However, whilst many of these technologies are available in automated milking systems e.g. conductivity, colour change and LDH they are still not widespread in their use due to issues surrounding their sensitivity, specificity and the expense associated with the installation of testing units and running each diagnostic test (A J Bradley, Barkema, et al. 2012)

During the 1960s the national mean bulk milk somatic cell count (BMSCC) was close to 750,000 cells/ml and this in conjunction with high levels of clinical mastitis led to the introduction of the Five Point Plan (Booth 1997). This initiated a subsequent decrease in the national BMSCC, along with the introduction of targets for milk quality introduced by milk buyers stimulated by the introduction of the European Commission Milk Hygiene Directive (92/46/EEC) in 1992 (European Commission 1992). This made it illegal to supply milk after a period of three months of a three-month rolling geometric mean BMSCC > 400,000 cells/ml. Despite this, BMSCC had started to rise again at the beginning of this decade to close to 200,000 cells/ml (See Figure 1).

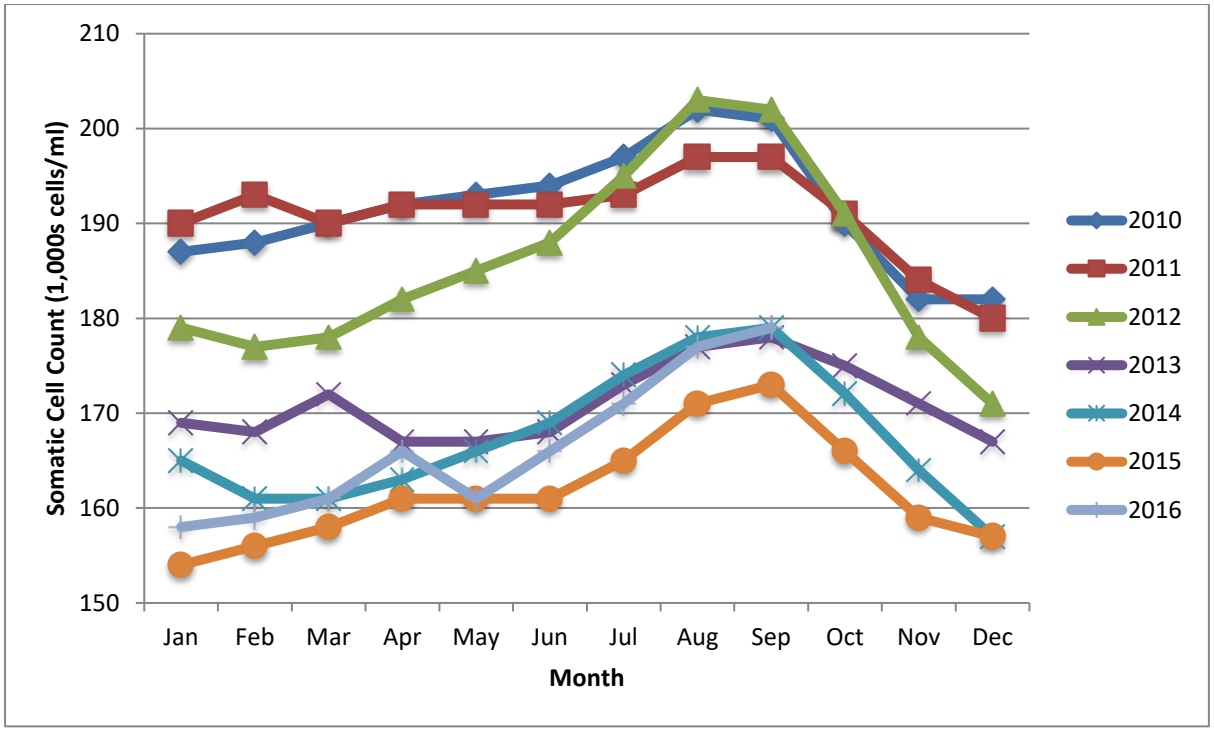


Figure 1. Monthly bulk milk somatic cell count (BMSCC) trends for 2010 - 2016 (AHDB, 2016).

However, since 2013 this trend appears to have reversed with the monthly BMSCC average for 2015 and 2016 being 162,000 cells/ml and 166,000 cells/ml, respectively compared to 2010, which averaged 199,000 cells/ml (AHDB Dairy 2016). This is clearly unlikely to be the result of the Five Point Plan and might suggest the more recently initiated AHDB Mastitis Control Plan could be having an influence of national BMSCC trends.

However, these apparent trends in national figures should not be assumed to be truly representative of the complete picture present on UK farms. It must be remembered that BMSCC is a very crude parameter to assess udder health performance on farms due the influence of stage of lactation, calving pattern and culling.

5.5 Aetiology

Mastitis may have an infectious aetiology as a result of bacterial, mycoplasma, yeast and alga and a non-infectious aetiology as a result of trauma for example (Bradley 2002; Blowey

& Edmondson 2010a). Classical definitions of mastitis aetiology have tended towards dividing the relevant pathogens into contagious and environmental groupings. Contagious pathogens being those which are host adapted with their primary residence being within the mammary gland or on its skin. Spread of these pathogens tends to occur during milking from infected cows/quarters with the milking machine acting as a major vector for the spread of these pathogens or after milking. However, parlour operatives and other equipment utilised within parlour may also act as vectors or allow transmission via fomites. This traditional classification has incorporated pathogens including major ones such as *Streptococcus agalactiae*, *Staphylococcus aureus*, *Streptococcus dysgalactiae*, *Mycoplasma spp* and minor pathogens such as *Corynebacterium bovis* and *Coagulase-negative staphylococcus*. Environmental pathogens major reservoir of infection is the environment. Infection occurs both during interaction with the housed environment and during the milking process usually as the result of teat end impacts. Those pathogens classified as environmental include the *Enterobacteriaceae*, *Streptococcus uberis Streptococcus faecalis, Pasteurella, Bacillus spp,* Yeast and Fungi (Blowey & Edmondson 2010b).

In the UK during the first half of the 20th century, mastitis was identified as a condition of importance in dairying and subsequent classification occurred by pathogen and clinical presentation; leading to the traditional categories mentioned previously (Green & Bradley 2013). During the 20th century, mastitis was predominantly of contagious origin and dominated by *Staphylococcus aureus* and *Streptococcus agalactiae* (Green & Bradley 2013). However, since the 1980s the aetiology of mastitis was changing with *Streptococcus uber*is and *Escherichia coli* becoming more prevalent mastitis pathogens (Green & Bradley 2013). A survey during 2004 - 2005 of 480 cultured clinical mastitis samples supported this with

Streptococcus uberis and *Escherichia coli* being the most prevalent pathogens, representing 23.5% and 19.8% respectively (A J Bradley, Green, et al. 2012). Subclinical mastitis samples collected during this survey numbered 464 with 13.8% and 5.2% culturing *Streptococcus uberis* and *Staphylococcus aureus* respectively. However, nearly 40% returned a no growth (A J Bradley, Green, et al. 2012). Clearly environmental pathogens have been more prevalent though contagious pathogens are still present and cause problems on some farms. However, categorisation of herd disease patterns from more than 1000 farms enrolled in the AHDB Mastitis Control Plan between 2009 – 2012 classified 92% of farms with an environmental pattern, 6% as contagious and 2% as mixed (A J Bradley, Green, et al. 2012). Clearly, the aetiology of mastitis has changed but also the patterns of behaviour evident can also be different to what we initially perceived. Recent evidence has highlighted the ability of *Escherichia coli* to behave almost contagiously and persist in the udder over long periods of time (Bradley & Green 2000), for *Staphylococcus aureus* to circumvent normal control measures as a result of a possible environmental reservoir (Sommerhäuser et al. 2003) and for *Streptococcus uberis* to behave in both a contagious and environmental pattern (Zadoks et al. 2003).

The diversity of pathogens involved in bovine mastitis is widespread with a total of 137 species, microbial species, subspecies and serovars having been isolated (Watts, 1988). More recent work from 6,005 samples obtained from over 500 UK farms found in excess of 100 different bacterial species (Payne et al. 2013). The predominant pathogens represented were Gram-negative bacteria, especially the coliforms, which included *Escherichia coli*., *Klebsiella* spp., *Serratia* spp., *Citrobacter* spp. and *Pseudomonas* spp. Within the Gram-positive bacteria, many *Streptococci* spp. are recognised as important environmental

pathogens including *Enterococcus* spp., which exhibits many antibiotic resistance profiles; others identified included *Lactococcus* and *Aerococcus* spp. Furthermore, yeasts such as Candida were identified and algae such as Prototheca, which are unbiquitous within the environment (Breen et al. 2015).

5.6 Management

The control of mastitis in dairy herds remains one of the largest opportunities for veterinary surgeons to give preventive management advice on a routine basis. Recent research would suggest that proactive intervention is infrequent with fewer than 20 percent of dairy vets providing this service to greater than 3 clients (Higgins et al. 2013). A recent study highlighted the benefits of participation in herd health programmes using a survey of more than 1000 Dutch herds. This reported average gains of €95 per cow per year compared to a herd health cost of €20 per cow per year; a cost:benefit ratio of 1:4.8 (Ifende et al. 2014).

Mastitis must be managed by aiming to reduce the incidence rate of new infections rather than treating infected cows to control herd prevalence of infection. To achieve long term success we must understand where new intra-mammary infections (IMI) arise and ensure the reduction of incidence is the main thrust in the development of a mastitis control program (Bradley, Barkema, Biggs, Green, and Lam 2012). To achieve this it is important to categorise the predominant epidemiological pattern on a herd by herd basis. A 'one size fits all' approach, which makes generic recommendations in a small number of areas will not suffice.

More recently routine examination of somatic cell count (SCC) records was used to supplement this approach and manage infected individuals, often with antimicrobial therapy. This focus on prevalence often led to advice targeted around the milking process.

Further management changes were often not based on rigorous herd data analysis and an epidemiological approach (Green & Bradley, 2013).

The rising importance of environmental pathogens such as *Streptoccocus uberis* and *Escherichia coli* (Green & Bradley, 2013) has led to a greater focus on identifying areas of risk. This has led to the application of critical control points to remove risks or minimise their impact, which is proving extremely challenging and is the focus of a significant body of research (Beekhuis-Gibbon et al. 2011; Green & Bradley, 2013). This is unsurprising considering the rapidly changing on farm environment and mastitis problems tending to have different risk factors (Beekhuis-Gibbon et al. 2011).

Recently, a preventative approach to tailor individual mastitis control plans to the disease pattern on farm has been initiated. This has been validated by UK research and ensures that the critical control points implemented are targeted objectively to optimize health, welfare and production (Green et al., 2006; Dairy Co. Mastitis Control Plan (DMCP) www.mastitiscontrolplan.co.uk).

5.6.1 Preventing new infections

To do this we must establish whether the most significant source of infection arises from the dry or the lactating period and whether transmission of infection is occurring from cow to cow or from environment to cow. Improvements in monitoring and understanding of the epidemiology of mastitis have allowed this to become possible. Achieving this herd level diagnosis of the predominant pattern is essential to allow a veterinary surgeon or adviser to target advice to the most significant risks on farm. To succeed in this requires regular collection of SCC and clinical mastitis data from electronic records of milk recording data (e.g. National Milk Records), on farm software (e.g. Total Dairy, SUM-IT Computer Systems

Ltd) and/or written records. This will result in characterisation of the predominant pattern, allowing the situation on farm to be dealt with.

5.6.2 Targeting interventions

A detailed farm management plan of objective interventions must be drawn up. Environmental mastitis control must focus on steps to reduce infection pressure and maximise immune function to combat challenge (Bradley, Barkema, Biggs, Green and Lam, 2012). Identification of sub-optimal areas within these two categories is essential.

5.7 Economic Losses

The economic implications of uncontrolled clinical and subclinical mastitis can often be underestimated and as highlighted earlier mastitis is the most common and costly endemic disease in the dairy industry worldwide.

Costs associated with mastitis can be assumed to occupy to distinct areas (1) prevention and continual monitoring of udder health indices as part of a herd health approach and (2) costs associated with the disease (Bradley, Barkema, Biggs, Green and Lam, 2012). Many risk factor based studies exist relating to udder health management, however the efficacy of interventions based on these studies and their associated cost benefit is not well understood (Huijps & Hogeveen 2007; Bradley, Barkema, Biggs, Green and Lam, 2012). However, very recent research attempts to elucidate the clinical effectiveness of specific mastitis interventions on farm with regard to their cost effectiveness (Down et al. 2016).

Costs may be broken up into direct (farm labour, treatment, milk discard, veterinary time etc.) and indirect (lost milk in the remainder of the lactation, increased risk of culling etc). Direct costs often form a much smaller proportion of the overall cost relative to indirect

costs and these are often the only ones seen or accepted by a client. The hidden or indirect costs can be much more difficult to convince a client of and therefore realise the large effect mastitis has on farm profitability (Down et al. 2013).

5.7.1 Clinical mastitis costs

Costs of clinical mastitis	
Direct	**Indirect**
Treatment costs	**Yield loss in remaining lactation**
Herdsman time cost	**Potential for recurrence and associated costs**
Veterinary surgeons time	**Increased risk of culling**
Discarded milk	**Spread of infection within herd**
Mortality	**Increased preventative costs**
	Lost genetics due to culling
	Increased BMSCC
	Increased Bactoscan
	Antibiotic milk residues failures

Table 1. The direct and indirect costs of clinical mastitis. Taken from Dairy Herd Health (2012) (Bradley, Barkema, Biggs, Green and Lam, 2012).

A number of studies have attempted to estimate the cost of a case of clinical mastitis with a range of $179 – 461 (direct and indirect costs) (Bar et al. 2008; Huijps et al. 2008; Hagnestam-Nielsen & Ostergaard 2009). Though, these averages must be interpreted with caution and can be difficult to apply when dealing with an individual farm client (Down et al. 2013). In addition, the aforementioned studies are now at least a decade old and not directly comparable to the present. Costings within these type of evaluations will be driven

by world market prices of major commodities including cereals and crude oil, which will have a direct impact of feed costs, diesel and fertiliser costs. These may show fluctuations over time due to changes in exchange rates, supply and demand of commodities, the opening or closing of markets, exchange rates changes and tariffs to name a few influencing factors.

5.7.2 Subclinical mastitis costs

Subclinical mastitis cost are defined along similar lines to clinical mastitis. However, they can be more difficult to define. Direct costs may relate to treatment, labour time and discarded milk. Treatment of cows with subclinical mastitis should not form the basis of an udder health management strategy. Indirect costs relate to increases in BMSCC and resultant penalties by milk buyers. SCC penalties are typically 0.5 - 1.0ppl over a threshold using a 3 month geometric mean with bands being applied at either 200,000 or 250,000 cells/ml in the UK dependent on the milk buyer (Cooper, 2016).

Indirect effects of elevated BMSCC may also include depression of milk yield. Every 100,000 cells/ml greater than 200,000 cells/ml decreases herd yield by 2.5% (Bradley, Barkema, Biggs, Green and Lam, 2012). In addition, opportunity costs must also be considered within indirect losses. These might include the failure to achieve bonus payments if available, putting constraints on culling, limiting the opportunity to cull animals which economically were more important or the diversion away from other important management areas on farm e.g. fertility management.

6 The Dry Period

The dry period is an important time for optimising udder health and milk quality with, the aim of cure of existing intra-mammary infection (cure IMI) and preventing the acquisition of new intra-mammary infection (new IMI) (Eberhart, 1986; Bradley and Green, 2000; Dingwell et al., 2004). It is well established that new IMI may be acquired during the dry period and that these have a negative impact on udder health in the subsequent lactation (Bradley and Green, 2000; Green et al., 2002; Pantoja et al., 2009). New IMI present at the first test day of a new lactation can have significant financial implications as a result of deleterious effects on milk yield, quality, and further implications in terms of antimicrobial use and dairy cow welfare (Bradley & Green 2000; Archer et al. 2013b; Archer et al. 2013c; Archer et al. 2014).

The transition of SCC from last test day before drying off to first test day after calving has been reported to be a useful method to assess performance of individuals and groups across the dry period (Cook et al. 2002; Whist & Osterås 2007). Prediction of risk profiles for individuals or groups of cows would be of particular interest because appropriate management practices could be targeted towards these animals. This may include alteration of the environment (Green et al. 2007; Green et al. 2008), changing dry cow therapy (Halasa et al., 2009a; b) or culling/segregation of animals with a remote likelihood of cure in the subsequent lactation. Some cow level risk factors for cure IMI have been reported and include number of quarters infected, age, SCC and dry period length (Osterås et al. 1999; Dingwell et al. 2003; Church et al. 2008). Risk factors for new IMI at the cow level have also been identified, including milk yield at drying off, parity and dry period length (Huxley et al. 2002; Dingwell et al. 2004; Church et al. 2008). Previous studies have shown SCC < 200,000 cells/ml within 90 days prior to drying off is significantly associated with reduced risk of

clinical mastitis and subclinical mastitis in the next lactation (Green et al. 2007; Green et al. 2008). The best association between composite SCC at drying off and future composite SCC in the next lactation was found using at least two test days prior to drying off (Whist & Osterås 2007). An individual cow's probability of failure to cure has been estimated at the point of drying off and highlighted that the geometric mean natural log of the last three test days for composite SCC had the best association with the probability of failure (Osterås et al. 1999). However, no studies have used full lifetime cow records and SCC to create a risk profile for dry period outcomes at the point of drying off.

6.1 Management

Managing dry period origin infections will focus on areas such as drying off procedures, dry cow therapy (DCT) selection, environmental management in the dry period, nutrition and maximising immune function.

Milk yield at drying off has been shown to increase the likelihood of a new IMI during the dry period or at calving (Dingwell et al. 2002; Huxley et al. 2002; Rajala-Schultz et al. 2005; Odensten et al. 2007; Newman et al. 2009). Drying off during milking and failure to clean teats with surgical spirit during DCT administration significantly increases the risk of clinical mastitis (CM) and elevated SCC in early lactation (Green et al. 2007; Green et al. 2008).

Herd management factors related to hygiene are significantly associated with increased rates of CM and SCC in early lactation such as pasture grazing policies failing to 'rest 4 graze 2' as S*treptococcus uberis* can survive for 2 weeks on paddocks under optimal conditions (Green et al. 2007; Lopez-Benavides et al. 2007; Green et al. 2008).

Providing transition yard areas >1.25m² per 1,000kg annual mean cow milk production and even coverage of bedded areas have been demonstrated as significant risk factors in the reduction new IMI. These link with common sense approaches such as daily bedding, scraping, regularly whole yard cleaning, adequate ventilation and provision of loafing areas in further reducing the risk of new IMI during the dry period (Green et al. 2007; Green et al. 2008). These interventions are essential to control environmental pathogens as it has been demonstrated that of enterobacterial mastitis occurring in the first 100 days of lactation, 52.6% arose in quarters previously infected during the dry period and 92% of cows infected with *Streptococcus uberis* during the dry period developed CM in the first 120 days of lactation (Bradley & Green 2000; Oliver et al. 1998).

Routine management procedures such as body condition scoring at drying off, fore-milking within 4 hours of birth, cross suckling and cleaning calving pens are all significantly associated with reduced risk of dry period IMI and improved udder health in early lactation (Green et al. 2007; Green et al. 2008). However, DCT remains a cornerstone of mastitis control and is discussed later.

6.2 Review of factors influencing dry period performance

6.2.1 Parity

Many studies exist discussing the role of parity with respect to its influence on dry period performance (Dingwell et al. 2004).

6.2.1.1 Cure IMI versus New IMI

The influence of parity has been highlighted in a study examining major pathogen clearance across the dry period with those individuals having had at least one lactation prior to drying

off being less likely to achieve cure IMI (Osterås et al. 1999). Further work demonstrated non-treated cows across the dry period had a significantly lower odds of being culture negative 6 days post calving if greater than parity 3 (Osterås et al. 2008). When treated at drying off parity had no effect on outcome 6 days post calving. This maybe as a result of the antimicrobial treatment minimising this as a risk factor (Osterås et al. 2008). Parity has been shown to have a significant influence on the cure of SA at the cow level (Sol et al. 1994).

Higher cure IMI has been associated with a lower new IMI rate when using SCC as a proxy for infection (Madouasse et al. 2012). Furthermore, the probability of having a high SCC at first test day of a new lactation (definition of failure to cure IMI in the model) significantly increased with increasing parity (Madouasse et al. 2012) and though this factor was significant at the cow level, it explained very little of the herd level variation. A previous study in which most of the new IMI were environmental found IMI was 19%, 14%, 31% and 31% for first, second, third and fourth parity respectively. This is suggestive of parity as a risk factor for the development of new IMI across the dry period. However, this was only a descriptive analysis (Dingwell et al. 2004; Pinedo et al. 2012).

In contrast a study examining dry period cure of SA, it was found age was not a significant risk factor either at the cow or quarter level. Though, cure rates were seen to be slighter higher in cows ending their first lactation (Dingwell et al. 2003). Parity was not significantly associated with infection status at calving measured by bacteriology 3 days post calving (Newman et al. 2009).

6.2.1.2 Clinical versus subclinical mastitis

Parity has been shown to be a cow level covariate associated with SCC & CM in early lactation. Cows of higher parity being significantly more likely to have a SCC > 199,000

cells/ml and an increased risk of first case of CM in the first 30 days of the next lactation (Green et al. 2007; Green et al. 2008). Cows of greater parity and in particular those greater than 3rd parity were at increased risk of clinical mastitis, in a study examining pathogen profiles across the dry period and the occurrence of clinical mastitis in the subsequent lactation (Green et al. 2002). This supports older research, which found the incidence rate of clinical mastitis increased with increasing age subsequent to second lactation (Miller et al. 1976).

6.2.1.3 Immunosenescence

The theory of age or parity having an influence on immune function is corroborated by human research highlighting "immunosenescence". This is a term collectively used to describe the aged immune systems reduced capability in mounting an effective immune response to pathogen challenge (Solana et al. 2006).

Defence against mastitis pathogen incursion incorporates a range of modalities including the physical, soluble and cellular defences (Bradley, Barkema, Biggs, Green and Lam 2012). The quality of the physical seal (teat orifice, streak canal and keratin plug) at the teat end will be tested with time spent within the milking herd. It is also known that the integrity of the streak canal is reduced (Cousins et al. 1980) with increasing parity. A combination of physical trauma unrelated to milking or directly related to milking and sub-optimal parlour maintenance resulting in severe teat hyperkeratosis will increase the chance of infectious challenge becoming established (Bradley, Barkema, Biggs, Green and Lam 2012; Hudson et al. 2012). The adaptive immune system can be included within both the soluble and cellular defences and innate immune system takes the cellular form in udder health protection. The adaptive immune system is known to significantly deteriorate with age in humans (Weng

2006) and whilst some cellular components of the innate immune system are recognised to be largely unaffected by ageing change i.e. natural killer cells, others such as neutrophils and macrophages can suffer from a number of effects (Solana et al. 2006).

It should be mentioned that many differences exist between these studies in their definition of infection, cure of infection, frequency of testing and range of herd numbers and herd sizes included, which may explain the differences seen.

6.2.2 Season

A higher rate of cure IMI and lower new IMI rate for cows calving between July and November has previously been shown as measured by SCC (Madouasse et al. 2012). However, a tendency for quarters from cows calving in the summer versus those calving in the spring to be more likely to develop clinical mastitis has also been found (Green et al. 2002). Season has been shown to have a significant effect on the probability of cure IMI for cows infected with SA at dry off (Dingwell et al. 2003). Comparing those dried off in the spring (March-May) to those dried off in the winter (December-February); those dried off in winter were significantly more likely to achieve cure IMI (Dingwell et al. 2003). Bradley and Green (2001) have shown that spring relative to winter had a significantly reduced tendency for clinical coliform mastitis and non-coliform clinical mastitis in the dry period and up to 100 days post calving when assessing the efficacy of different dry cow treatments (Bradley & Green 2001b). In contrast, winter relative to fall has been shown to have a significantly increased risk of CM during the first 60 days post-calving (Pinedo et al. 2012).

However, season has also been suggested to have no effect on the probability of IMI at calving (Newman et al. 2009) with season being proposed as only responsible for only a

small degree of variation in the incidence of bacterial infection in the udder (Wilton et al. 1972).

6.2.3 Dry period length

A dry period length of 51 – 60 days (Bachman & Schairer 2003) is described as the recommended traditional length with Pinedo et al. (2011) finding an interquartile range of 57 -76 days in a study across 12,000 Holstein cows in 223 herds in Chile.

However, much of the research looking at this particular aspect of dairy herd management is based on retrospective rather than prospective studies (Annen et al. 2004).

6.2.3.1 Effect of short dry periods

Involution and colostrogenesis take on average 2 weeks with both of these periods considered of highest risk for new IMI (Bradley & Green 2004) and a tendency towards an increase in somatic cell score (SCS) has been seen with shortening of the dry period (Annen et al. 2004).

SCS in a study on Jersey cows has been shown to be increased for dry periods of 20 days, though was reduced compared to cows with 61 – 65 day dry periods. SCS decreased with a dry period of 21 – 30 days but was still higher than cows with at least a 60 day dry period (Kuhn et al. 2007). The negative impact on SCS was mitigated by dry period lengths of at least 45 days. Some of this effect of short dry periods on SCS was explained by lower milk yields in the next lactation. This author also previously found short dry periods to have a negative influence on SCS in Holsteins (Kuhn et al. 2006). The impact of short dry periods (less than 20 days) seems to be more important in Jersey versus Holsteins. Optimal was suggested to be 60 days in Jerseys (Kuhn et al. 2007).

It has in contrast been reported in the literature that dry periods of ≤30 days result in a lower number of new IMI than those with longer dry periods (Natzke et al. 1975). Short dry period (< 30 days) have been shown to have a significant relationship with subclinical mastitis early in the next lactation. Though, this was only found at second test day, not first or third, highlighting a reduced odds relative to a dry period length of 53 – 76 days (Pinedo et al. 2011). This is supported by later findings of the same author of a significantly reduced odds of subclinical mastitis in the first 30 days after calving relative to a long dry period (Pinedo et al. 2012). In other studies investigating SCC and SCS in the next lactation there has been a tendency for these measures to be lower but not significantly for short dry periods (28 -30 days) relative to traditional dry periods (56 – 60 days) (Gulay et al. 2003; Rastani et al. 2005).

Short dry period length has also been shown to have a significantly reduced odds of CM within the first 30 days and 60 days after calving, relative to a long dry period (Pinedo et al. 2012) and improved cure IMI and fewer new IMI (Natzke et al. 1975).

6.2.3.2 Effect of longer dry periods

Two older studies have found new infection rate to be elevated in dry cows with longer dry periods than shorter (Natzke et al. 1975; Rindsig et al. 1978). The effect seen in these studies is likely as a result of the extended dry periods having no antimicrobial cover and cows where teat sealant was not being utilised having limited protection from new IMI in the transition period. More recently the number of dry days after dry cow therapy was shown to have an increased but non-significant tendency towards failure of cure IMI of major pathogens (Osterås et al. 1999). A further study investigated the use of teat sealants in cows with extended dry periods. Those greater than 16 weeks were found to have a

significantly greater prevalence of infections in the peri-parturient period compared to those cows receiving a traditional dry period of 6 – 10 weeks (Berry & Hillerton 2002). Subsequently, it has been found cows with extended dry periods (143 – 250 days) have a significantly increased odds of subclinical mastitis (SCS ≥ 4.5) at first, second and third test day relative to cows with a conventional dry period (53 – 76 days) (Pinedo et al. 2011). However, a trend for lower SCS was noted for longer dry periods specifically in Holsteins (Kuhn et al. 2006).

6.2.3.3 No effect of dry period length

Some studies have shown no association between dry period length and probability of cure IMI (Dingwell et al. 2003; Sol et al. 1994). Cows exhibiting a high SCC pre drying off having a longer dry period leading to an association between both factors in a univariable assessment, though none in the multivariable model (Sol et al. 1994). Length of dry period has also been shown to have no significant relationship with infection status post calving (Funk et al. 1982) Furthermore, it was not found to be a significant factor in the cure of *Staphylococcal aureus* infections at both the cow and quarter level (Dingwell et al. 2003).

Dry period length has also been found to have no effect on the incidence of clinical mastitis in the first 30 days of the following lactation, the first 100 days of the following lactation and whole of the next lactation (Green et al. 2002; Berry & Hillerton 2007; Green et al. 2008).

It has also been reported to have no association with SCC post calving (Green et al. 2008). In addition, no significant increase in somatic cell score was found comparing a 30 day, 60 day and without a dry period. However, the author highlighted great variation in SCS with all values being low (< 150,000 cells/ml) (Annen et al. 2004).

Shortening of the dry period from 55 days to 34 days has been shown to have no significant effect on SCS in the next lactation (Watters et al. 2008). It has also been indicated no significant difference exists for cure IMI, new IMI and linear SCC in the subsequent lactation in 30 day compared to 60 day dry periods and 30 day compared to 45 day dry periods (Church et al. 2008). Though, there was an improvement in cure IMI across the dry period in the comparison of 60 & 30 day dry periods in favour of 30 days in the descriptive analysis; though the majority of IMIs were minor pathogen infections (Church et al. 2008).

6.2.4 Lactation length

No significant effect on the likelihood of CM in the first 30 days of lactation was found with a lactation length ≤ 305 days, though an increased tendency was seen relative to a longer lactation (greater than or equal to 464 days) (Pinedo et al. 2012)

Intermediate lactation length (306 – 463 days) relative to a longer lactation has a significantly increased odds of CM in the first 30 days after calving. Intermediate lactation length relative to long (> 463 days) also had a significantly increased odds of subclinical mastitis in the first 30 days after calving, though this variable was not retained in the final model. This might indicate either failure to cure IMI or development of a new IMI during the dry period (Pinedo et al. 2012).

6.2.5 Body condition score

Herds which carry out monitoring of BCS during the dry period compared to herds where it is not recorded have been shown to have a reduced odds of CM in the first 30 days of the next lactation (Green et al. 2008).

Individual cows losing greater than 1 unit of body condition in the dry period are at greater risk of metabolic disease post calving (Kim & Suh 2003). Smith et al. (2017) quoting

Garnsworthy (2006) acknowledge the importance of the rate of mobilisation of body reserves across the transition period. The rate of mobilisation is likely to be greater in higher BCS (BCS ≥ 3.5) individuals in the dry period and its management is very important in the prevention of metabolic disease post-partum (Smith et al. 2017). Metabolic challenge during this time is known to have a negative effect on the functioning of the immune system, leading to immune suppression and increased likelihood of IMI (Suriyasathaporn et al. 2000).

6.2.6 Leaking Milk

Leakage of milk should allow bacterial entry into the udder and indicate patency of the teat orifice and streak canal. If occurring during the dry period it will allow bacterial penetration and the development of a new IMI or failure of cure IMI (Oliver et al. 1956; Cousins et al. 1980).

Cows leaking milk during a period of intermittent milking (roughly 2 weeks prior to drying off, with 60% of the cows being dried off with less than or equal to 5 kg of yield) prior to drying off have been shown to be 4 times more likely to develop CM and 6 times more likely to develop a major pathogen IMI during the dry period (Schukken et al. 1993). Though these results were reported from a single herd. An increase in the incidence rate of CM has also been noted when farmers report cows leaking milk on entry to the parlour or at other times (Peeler et al. 2000). The avoidance of milk leakage should therefore be avoided to achieve effective management of new IMI in the dry period (Bradley & Green 2004).

The prevalence of milk leakage has been reported to be 30% in the week post drying off (Schukken et al. 1993). More recently a large study conducted on commercial dairy herds in

Europe, Mexico, Brazil and the USA found a prevalence of milk leakage in the 3 days post drying off, of 27.75% (De Prado 2016).

Feed restriction is a recommended method in the UK to control milk leakage post drying off. In cows fed 8kg versus 16 kg (DM basis), 2 days post drying off 14% versus 42% were found to be leaking milk (Tucker et al. 2009). In a more recent study, milk leakage post dry off was found to be 75% versus 27% in cows abruptly compared to gradually dried off; though absolute number of cows in groups were small (Zobel et al. 2013). However, no significant difference in milk leakage between gradually or abruptly dried off cows has also been found (Gott et al. 2016).

6.2.7 Milk yield

6.2.7.1 Lactation yield

Previous lactation milk yield (corrected for 305d and mature cow basis) <9,583kg (low) relative to an intermediate category (9584 – 11773 kg) and high category (> 11773 kg) was significantly associated with the risk of CM in the first 30 days & 60 days after calving and risk of subclinical mastitis and CM in the first 30 days (Pinedo et al. 2012). Low lactation yield could be associated with poor udder health or other health complications during a prior lactation, which might explain these findings (Pinedo et al. 2012).

6.2.7.2 Yield at or around drying off

In a study evaluating the benefits of internal teat sealants cows were 1.06 times more likely to become infected with an enterobacterial IMI during the dry period for every 1 Litre increase in the last recorded milk yield (Huxley et al. 2002). Furthermore, every 5kg increase in yield above 12.5 kg at drying off as been shown to be significantly associated with the odds of having an environmental infection at calving at both the cow and quarter level

(Rajala-Schultz et al. 2005). Though this was in a single research herd compared to the 16 UK herds in the paper above.

Yields less than 10 kg prior to drying off (0 – 30 days prior) have been associated with reduced likelihood of elevated SCC in the next lactation (Green et al. 2008). Though, increased milk yield prior to drying off (last recorded) or 305 day wasn't found to be significantly associated with CM in the next lactation (Green et al. 2007; Green et al. 2008). Lower yields (5 – 11.4 kg) prior to drying off compared to medium (11.5 – 17.7 kg) and higher (17.8 – 29.5 kg) yields have been shown to have significantly lower percentage of quarters with an IMI one week post calving, though not at four weeks post calving (Odensten et al. 2007).

A later study found every 5kg/d increase in milk production at drying off, increased the odds of having an IMI at calving increased by almost 80% (Newman et al. 2009). However, this study was carried out on a single research herd.

In uninfected quarters in the last week prior to drying, their cumulative yield was significantly associated with post calving infection IMI. Those producing over 115kg (average 16.4kg/d) had a significantly increased odds of being infected than uninfected quarters producing less than 75kg (Newman et al. 2009).

6.2.8 Method of drying off

The method by which cows are dried off has been investigated in a number of studies. There are a variety of methods of drying off cows and these can either take the form of an abrupt cessation to milking or gradual/intermittent approach to milking frequency at the end of lactation can be applied (Natzke et al. 1975).

Current UK recommendation include a combination of feed restriction and abrupt cessation of milking (Down et al. 2016a). This is supported by a previous paper by Green et al. (2008) who recommended this approach to reduce yield prior to drying off by managing the plane of nutrition.

However, in a high yielding cow at drying abrupt cessation of milking could lead to the build-up of substantial pressure in the gland and teat canals. This could lead to milk leakage and teat canals remaining open for longer (Williamson et al. 1995; Dingwell et al. 2004; Odensten et al. 2007) and as highlighted in the previous section increasing milk yield at dry off is significantly associated with increasing IMI at calving (Dingwell et al. 2002; Rajala-Schultz et al. 2005; Odensten et al. 2007).

Intermittent milking though has been shown to reduce milk yield, result in a more rapid involution of mammary tissue and increase the natural protective factors which are present in the udder and milk such as lactoferrin (Bushe & Oliver 1987).

In a more recent study intermittently milked cows produced significantly less than the control cows during the final week of lactation. However, intermittent milking was more likely to be associated with IMI at calving than control (abrupt finish with twice daily milking in the last week) (Newman et al. 2009).

Intermittent milking appears to have two opposing effects. It reduces milk yield prior to drying off and provided a protection effect through lowered milk yield, but it would also increase the risk of IMI at calving. Though this study was also only limited to a single herd and management style (Newman et al. 2009).

The mechanisms at play here may be related to a slower rate of teat closure in cows with a higher milk yield at drying off (Dingwell et al. 2002). In this study 23.4% of teats were still classified as open after 6 weeks. Teats that closed during the dry period were found to be less likely to develop a new IMI (Dingwell et al. 2002).

Williamson et al. (1995) has shown use of dry cow therapy increases the rate of development of the keratin plug. Hayton (2003) also showed that only 20% of teats formed a functional seal by the late dry period in cows in organic herds not receiving dry cow therapy (Williamson et al. 1995; Hayton 2003). This may be related to the removal of *Corynebacterium spp*., which have proposed keratinolytic properties thereby affecting teat plug formation and protection from new IMI (Bradley & Green 2004).

6.2.9 Soluble defence factors

A range of factors exist within milk and/or udder secretions during the dry period to moderate the mammary glands ability to prevent or respond to infectious challenge during this time.

Lactoferrin is known for its ability to inhibit bacterial growth in particular those of the enterobacterial group and *also Staphylococcus spp.* (Sordillo et al. 1997). The glycoprotein derives this characteristic as a result of its reversible iron binding, which in turn makes iron unavailable to the enterobacterial group thereby inhibiting their growth as iron is essential to this (Bradley & Green 2004). Further enhancement of this ability to control bacterial growth during the dry period also exists due to a relative increase in lactoferrin to citrate within the mammary gland (Zobel et al. 2015). Citrate also binds iron, though it remains available to enterobacteriaceae (Bradley & Green 2004). The relative change in magnitude of lactoferrin and citrate during the dry period improves lactoferrins ability to mediate

growth of this bacterial group. The level of lactoferrin at drying off appears to be significantly influenced by management leading up to drying off. Intermittent milking appears to result in significant increases compared to abrupt cessation of milking (Newman et al. 2009). However, the concentration at drying off was not significantly associated with the likelihood of IMI at calving, cure IMI or the development of new IMI in the dry period (Newman et al. 2009; Newman et al. 2009b). Lactoferrin is also proposed to play a role in the activity and regulation of the immune system in particular macrophages, lymphocytes and neutrophils (Zobel et al. 2015). In addition it is known to have a synergistic relationship with IgG specifically controlling the growth of bacteria such as *Escherichia coli* and *Klebsiella spp.* (Bradley & Green 2004; Zobel et al. 2015).

Leucocyte populations also increase in the mammary gland after drying off as the environment becomes more favourable to their presence. Initial high concentrations of fat globules and casein at drying off fall during involution encouraging their increased presence (Bradley & Green 2004). Other soluble defence factors increase during the dry period such as IgG and help regulate infectious challenge (Bradley & Green 2004).

6.2.10 Infection dynamics over the dry period

The dynamics of SCC from last test day before the dry period to first test day in the early postpartum period is a valuable method to assess performance of individuals and groups across the dry period (Cook et al. 2002; Whist & Osterås 2007). The gold standard of IMI detection is considered bacteriology and therefore is used in the majority of epidemiological studies (Madouasse et al. 2012).

6.2.10.1 Threshold & Early Lactation

Traditionally in the UK a threshold of SCC < 200,000 cells/mL is used to classify individuals as "uninfected" and SCC ≥ 200,000 cells/mL classified as "infected". Much debate exists around SCC thresholds for defining infection status of individual cows on milk recording. A SCC < 100,000 cells/ml has been identified to be normal in a healthy udder, however it cannot be considered as a definitive threshold to classify all cows as uninfected and infected (Barkema et al. 2009). A range of authors have examined this relationship and McDermott et al. (1982) estimated the SCC threshold 200,000 cells/ml to have a sensitivity of 89% and specificity of 75%. This study examined 719 cows (719 samples) from 12 herds , with infection being defined only when major pathogens were found and composite SCC samples used (McDermott et al. 1982). A further study in one herd of 25 cows involving collection of individual quarter milk samples (1565 samples) looked at various SCC thresholds; differences also existed in the classification of infection. If only major pathogens were included in the disease positive group using the threshold 200,000 cells/ml and disease negative included no growth and minor pathogens a sensitivity and specificity of 83% and 59% were found respectively. Including minor pathogens in the disease positive group changed this to 73% and 86% respectively and only major pathogens in positive group and no growths in the negative group resulted in 84% and 86% respectively; assessment was carried out at the cow level (Dohoo & Leslie 1991).

Schepers et al. (1997) took this further though the prevalence of IMI was very low in this study (3%). This study examined 22,467 quarter samples from 544 cows in 7 herds and a threshold of 200,000 cells/ml resulted in a sensitivity and specificity of 75% and 90% respectively (Schepers et al. 1997). Though, in this study IMI definition again differed and parameters were calculated at the quarter level.

A further and final more recent study found using this threshold for quarter milk samples had a sensitivity of between 64 – 69% when measured at dry off, post calving and first test day. Specificities were 66% (dry off), 84% (post calving) and 93% (first test day). Composite samples reduced sensitivity and specificity to 40 – 47% and specificity to 80 – 82% when measured at last test day pre dry and first (Pantoja et al. 2009a); this study did include minor pathogens in their definition of IMI.

Furthermore, examining the transition of SCC across the dry period using a threshold of 200,000 cells/ml has been commonplace in the UK for a number of years and supported by a range of authors as a method to identify new IMI (Cook et al. 2002; Bradley & Green 2005).

Associations have been identified between the interval from calving to first milk recording and level of SCC (Green et al. 2008). Elevated SCC in the post-partum period is a result of a physiological rise and brings into question its usefulness as an indicator of the likelihood of the presence of an IMI exiting the dry period (Barkema et al. 1999). It has been proposed that milk recording estimations of SCC should not be considered in primiparous and multiparous for the first 9 days and 11 days of lactation, respectively (Dohoo 1993). However, elevation in SCC in early lactation has been estimated to range from between 5 and up to 35 days (Reichmuth 1975; Sheldrake et al. 1983).

6.2.10.2 Previous Lactation SCC

A range of other independent variables were also identified to have significant associations with the likelihood of cure IMI failure (major pathogen) across the dry period (Osterås et al. 1999). These include the mean natural log of all SCCs during the lactation prior to drying off, weighted SCC during lactation, log of SCC at the last sampling prior to drying off, mean log of

the last two SCC prior to drying off, weighted mean of the last two SCC, mean log and weighted mean of the last three SCC prior to drying off (Osterås et al. 1999). These findings would also be in agreement with another paper highlighting composite SCC over a 5 month period is a better predictor for infection than samples at the exact time or for means of 2, 3 and 4 months (Osterås et al. 1999; Meek et al. 1980). In Norway samples are taken every second month hence this would span 5 – 6 months. This would reflect status over a long period and the tendency of the infection to be chronic (Osterås et al. 1999).

A number of herd level variables were also identified in the same study as being significant independent predictors of the likelihood of a cow being a failure to cure. These being weighted mean SCC for all sampling in the herd and geometric mean of all SCC samples in the herd (Osterås et al. 1999).

Within the multivariable models the weighted mean of SCC in the herd and the mean of the last three SCC was significantly associated with the probability of a cow being identified as a failure early in the next lactation. However, the average over the whole lactation was a slightly poorer predictor than the using the last three SCC (Osterås et al. 1999).

Furthermore, the incidence of new SCC below 200,000 cells/ml over a lactation at the herd level has been shown to be a significant predictor of a cow failing to cure across the dry period in a multivariable analysis (Osterås et al. 1999). This measure would indicate cure rate overall within the herd or conversely lactation new infection pressure and would suggest particular herds apply management process or manage the environment in such a way as to influence apparent cure across the dry period (Osterås et al. 1999). A similar relationship was also identified in the UK national mastitis control plan whereby herds,

which tended to have better cure rates across the dry period also tended to have low dry period new infection rates (A J Bradley, Green, et al. 2012).

Including bacteriology at the cow level at drying off improved sensitivity and specificity of the prediction of cure IMI. An estimation of bulk milk SCC and a high incidence of new IMIs within lactation were also highlighted as being a significant predictor of a failure of cure IMI. This study did have very few environmental streptococci and may not be so applicable to the UK where these and *Streptococcus uberis* predominate (Bradley et al. 2007).

Previous lactation somatic cell count score (SCS) average has also been shown to have a significant effect on the likelihood of incidence of CM in a subsequent lactation (Pinedo et al. 2012). Lactation SCS average ≥ 4.5 was considered to indicate the presence of subclinical mastitis and is supported an a indicator/proxy of infection (Moore et al. 2005; Pinedo et al. 2012). The univarable analysis within this study highlighted a significant effect of previous lactation SCS average ≥4.5 on the risk of positive bacteriological culture at calving, the risk of CM within 60 days after calving and the risk of subclinical mastitis in the first 30d and 60d after calving (Pinedo et al. 2012). In the multivariable analysis, a previous lactation SCS average was significantly associated with the risk of positive bacteriological culture at calving, the risk of CM in the first 60d after calving and the risk of subclinical mastitis in the first 30d and 60d after calving (Pinedo et al. 2012).

Green et al. (2004) have investigated the distribution of SCC during lactation as a method to predict or identify characteristics, which could be associated with CM during that lactation (Green et al. 2004). This research suggested there exists a limitation in the use of lactation mean log SCC to predict the occurrence of CM. Instead, their inference was to suggest that further investigation or use of patterns or distributions of SCC would aid the prediction of

udder health events. Their analysis indicated using the maximum and standard deviation of lactation log SCC improved the ability to predict CM compared to geometric mean SCC (Green et al. 2004).

6.2.10.3 SCC at Drying Off

Further investigations examining the effect of SCC at drying off have been performed in a study involving 219 cows and 308 quarters which were determined as naturally infected with *Staphylococcus aureus*, receiving randomized treatments of tilmicosin or cloxacillin at drying off (Dingwell et al. 2003). Cure rate was observed to be higher for those cows with a linear score less than 5 on their last test day. A significant difference in cure rate was found with 70.9% of cows with a LS <5 curing, compared to 56.4% with a LS ≥ 5 ($P<0.05$); though this was a univariable analysis. When linear score at dry off was examined in a multivariable analysis at the quarter level a higher score tended to decrease the probability of cure at the quarter level and at cow level (Dingwell et al. 2003).

One or more somatic cell count ≥200,000 cells/ml within 90 days before drying off has been shown to be associated with an increased rate of CM in the next lactation (Green et al. 2007). Some IMIs are likely to extend from the end of one lactation to the beginning of the next. Therefore, in this group it is unsuprising that there would be an increased risk of CM in the following lactation (Green et al. 2007). SCC 0 – 30 days and 31 – 60 days before dry off > 199,000 cells/ml was also significantly associated with an increased odds of SCC > 199,000 cells/ml within 30 days of calving for cows housed during the dry period. SCC 0 – 30 days was significantly associated a SCC > 199,000 cells/ml within 30 days for cows at pasture (Green et al. 2008). It is likely not all infections acquired pre-drying off are cured during the dry period or high SCC pre-drying off acts as a marker for susceptibility to the acquistion on

IMI during the dry period (Green et al. 2008). This relationship is further evidenced in a study by Madouasse et al. (2012), where those cows classified as high SCC before drying off were more likely to be classified as high at the first recording of the subsequent lactation (Madouasse et al. 2012). Furthermore, the probability of cure of an infected quarter decreased when SCC increased pre drying off (Sol et al. 1994). Variables predicting complete bacteriological cure of a cow were log SCC and probability of cure decreased as SCC increased. Age and SCC were positively correlated, but both remained significant in the multivariate analysis (Sol et al. 1994).

Average SCC over 3 months prior to drying off and quarter level SCC at dry off were also found to be significantly associated with infection status at calving in univariable analysis. However, when these were included in the final multivariable model they did not remain significant (Newman, J. Rajala-Schultz, et al. 2009).

Subclinical mastitis at dry off was also significantly associated with subclinical mastitis in the first 30d and 60d after calving (Pinedo et al. 2012).

6.2.10.4 Presence of Major Pathogens

Cure IMI without the administration of dry cow therapy could be expected to be close to 25 – 38% for cows infected with *Staphylococcus aureus* at drying off (Osterås et al. 1999). The same author references himself (Osteras et al. 1994) and Browning et al. (1990), when suggesting in conjunction with dry cow therapy cure IMI would be expected to be 63 – 68% for quarters infected with *Staphylococus aureus* (Osterås et al. 1999; Newman, J. Rajala-Schultz, et al. 2009). The cure rate of *Staphylococcus aureus* IMI has also been reported to vary from 40 – 83% (Sol et al. 1994). Major pathogen IMI at drying off has also been

significantly associated with the probability of the presence of an IMI at calving (Newman et al. 2009).

More recent UK based research would suggest bacteriological cure rates across the dry period for coagulase positive staphylococci are in the range of 90 – 100% (Bradley et al. 2010; Bradley et al. 2011; Newton, Green, Benchaoui, Cracknell, Rowan & A. J. Bradley 2008). The large discrepancy in cure rates between these and in the studies previously referenced could be the result of other staphylococci. These would include *Staphylococus hyicus and Staphylococus intermedius*, which are coagulase positive staphylococci as are *Staphylococus aureus*. However, being minor mastitis pathogens these are not as difficult to achieve cure IMI.

Cure IMI of major pathogen infections following the administration of dry cow therapy is likely to be dependent on a number of factors. These include pathogen, cow level and herd level factors. The ability to predict specific individuals or quarters with an increased likelihood of cure IMI could be really beneficial to the livestock industry (Dingwell et al. 2003).

The majority of major pathogen IMI present at drying off have been found not to persist across the dry period. Less than 1.9% (4/212) of major pathogen IMIs have been found to apparently persist across the dry period (Bradley et al. 2011).

True failure of cure IMI for major pathogens during the dry period is highly unlikely. Apparent poor cure IMI evident when monitoring SCC dynamics across the dry period are likely due to cure IMI being achieved in the early dry period only to be followed by the occurrence of a new IMI in the mid to late dry period (Bradley & Green 2004; Bradley 2017).

The presence of IMI at drying off may indicate a susceptibility to infection and explain why most major pathogens do not persist the dry period, but their presence at drying off is associated with the presence of an IMI at calving.

In a univariable analysis bacterial culture at dry off with an environmental pathogen was significantly associated with CM in the first 60d after calving. In addition bacterial culture at drying off with a gram negative pathogen was significantly associated with CM in the first 30d after calving. The multivariable analysis in this study highlighted bacterial culture at dry off with a gram negative pathogen was significantly associated with the risk of CM in the first 30d after calving (Pinedo et al. 2012). However, bacterial culture with an environmental pathogen was not included in the final model; likely due to a lack of significance. This dataset involved 402 cows in 2 Floridian herds.

The incidence of enterobacterial infection of the udder during the dry period in 629 cows across 6 South West UK dairy herds has also been investigated. Interestingly, 45% of CM cases developing in the first 100 days in milk were Enterobacterial infections, of which 53% had been previously isolated during the dry period (Bradley & Green 2000).

The likelihood of a quarter suffering a case of clinical mastitis was increased when *Streptococcus dysgalactiae, Streptococcus faecalis, E. coli or Enterobacter spp.* were identified by bacterial culture at drying off (Green et al. 2002). Furthermore, when *E. coli,* coagulase positive *Staphylococcus, Serratia spp. or Streptococcus faecalis* were cultured in two of the three transition and post calving samples taken the probability of CM caused by the same pathogens was also increased, when not infected with the same bacteria at drying off (Green et al. 2002). In addition, a trend for increased quarter susceptibility to IMI or increased likelihood of CM if infected with another organism (Green et al. 2002).

Specifically the risk of E. coli clinical mastitis in the next lactation was also increased with isolation of *E. coli* and *coagulase positive Staphylococcus* at drying off and isolation of *Streptococcus faecalis* and *E. coli* at least twice in the 2 weeks prior to calving and week post calving in quarters not infected with them at drying off. The risk of CM caused by *Streptococcus uberis*, *Streptococcus dysgalactiae* or coagulase positive *Staphylococcus* was significantly increased if the organism causing mastitis was isolated in at least two of the transition period samples (Green et al. 2002).

IMI present at both drying off and during the transition period increased the risk of clinical mastitis in the study. Late dry period infections with major pathogens increased the risk of clinical mastitis with the same organism, although it was not possible to determine whether these bacteria persisted through the whole of the dry period. Bradley and Green (2001) although indicate that this is possible (Green et al. 2002).

The predominant pathogens, which have been found post calving have been shown to be *Staphylococcus spp.* (5.59%), *Staphylococcal aureus* (3.35%) and *Streptoccus spp.* (1.7%). However, Green et al. (2005) identified *Escherichia coli* (5.53%) as the predominant pathogen isolated at calving from nearly 2000 samples followed by coagulase negative *Staphylococcus* (4.8%), *Corynebacterium spp.* (1.77%) and coagulase positive staphylococcus (1.51%) (Green et al. 2005). Though, Pinedo et al. (2012) referencing Dingwell et al. (2002) and Godden et al. (2003) highlight in their studies a larger proportion of samples with new IMI at calving were due to environmental streptococci than caused by coagulase negative staphylococci (Pinedo et al. 2012).

6.2.10.5 Presence of Minor Pathogens

The average number of quarters infected with coagulase negative *staphylococci* (CNS) pre drying off has been found to be significantly associated with an increased likelihood of cure IMI and therefore less likely to have a major pathogen infection post calving (Osterås et al. 1999). This finding was at the cow level and an independent variable assessment. There was also a significant finding at the quarter level for independent variables related to the presence of CNS. The model developed in this study aimed to predict cure IMI. In individuals receiving treatment when not recommended by the model only 24% of cows were uninfected versus those receiving no treatment when not recommended resulted in 33.3% uninfected post calving (Osterås et al. 1999). Therefore, CNS could be proposed to have a protective effect in this instance during the dry period. This may be suggestive of an effect whereby treatment disrupts the microbiome making cure IMI less likely in certain individuals (Osterås et al. 1999; Oikonomou et al. 2012; Oikonomou et al. 2014).

In contrast, quarters infected with minor pathogens at drying off have a significantly increased odds of being infected at calving than uninfected quarters (Newman et al. 2009). The definition of infection after calving did include the presence minor pathogens, though the threshold cfu/ml was 10 times that of a major pathogen. However, in Osteras et al. (1999) major pathogen presence was the inclusion criteria for defining infection.

An earlier study examining risk factors associated with the cure of *Staphylococcus aureus* (SA) during the dry period found associations with the presence of CNS (Dingwell et al. 2003). CNS at a similar threshold to Newman et al. (2009) was used to define infection, though what is not clear is whether it's presence post calving was used to define infection (Dingwell et al. 2003). In the final model investigating the probability of cure IMI of quarters

infected with SA, there was a tendency for an increased odds of cure associated with a concurrent CNS infection. The authors highlight the non-significance of the finding, though due to the size of the effect (OR = 5.1; 95% CI −0.171 – 3.460) feel it may be biologically important. This was not investigated in the cow level final model. It should also be highlighted that only 11 (3.6%) of 308 infected quarters had both a CNS infection and SA infection at the same time (Dingwell et al. 2003).

Corynebacterium spp. have been shown to be quite prevalent at drying off, being found in 35.7% of sampled quarters in a study surveying 954 quarters (Green et al. 2002). Though, at 8 -14, 0 – 7 days pre-calving and at calving its prevalence was only 2.6%, 2.8% and 1.7%, respectively (Green et al. 2002). The presence of *Corynebacterium* spp. in any one of three samples taken in the 2 weeks prior to calving and up to one week post calving at a quarter level and not infected with a major pathogen had a significant association with a reduction in the likelihood of future CM (Green et al. 2002).

However, quarters infected with *Corynebacterium* spp. at drying off were found to significantly more likely to succumb to CM at any time during the subsequent lactation (Green et al. 2002). Other authors have also highlighted that the presence of *Corynebacterium bovis* at drying off is associated with an increased risk of IMI during the dry period (Funke et al. 1997; Pankey et al. 1985).

The presence of *Corynebacterium* spp. in milk samples are suggested to be an indicator of poor teat hygiene (Bradley 2006). Therefore, presence at drying off associated with poor teat hygiene could have resulted in a continuation in this trend in suboptimal hygiene into the next lactation resulting in an increased risk of CM (Green et al. 2002). However, the presence of *Corynebacterium* spp. may indicate suboptimal teat condition such as teat

chaps or cracks which therefore rather than being a direct effect of its presence maybe an effect of compromised teat defences resulting in an increased risk of CM (Green et al. 2002). This association with the presence of *Corynebacterium* spp. has also been highlighted previously where they have been shown to increase the rate of environmental *Streptococci* and *Streptococcus agalactiae* infections. This research highlights that when *Corynebacterium* spp. infection occurs during the dry period maybe important in determining the risk associated with future CM (Green et al. 2002). Therefore, if the timeframe is important it could explain why Hogan et al. (1988) found there is an increase of risk of CM associated with *Corynebacterium* spp. presence, though in contrast Lam et al (1997) highlight the presence of minor pathogens such as *Corynebacterium* spp. can possibly have a protective effect against major pathogen infections (Hogan et al. 1988; Lam et al. 1997). Is the result a competitive exclusion effect or due to an elevation of SCC associated with their presence, which may result in the reduction in the risk of associated CM caused by major pathogens (Lam et al. 1997). What is not also well understood is the influence that a specific species or strain could have on this relationship and also whether presence at any time is important or whether *Corynebacterium* spp. must actually be present when a challenge of a major pathogen is presented to the udder or quarter (Green et al. 2002). Limitations within this study were that sampling only involved a single sample at drying off rather than sequential sampling and that only 4.4% of quarters (42/954) were found to be infected with *Corynebacterium* spp. As a result, the beneficial effects of its presence are unlikely to be of huge significance (Green et al. 2002).

The presence of *Corynebacterium spp.* during the dry period resulted in fewer cows, which received teat sealant alone acquiring major pathogen infections during the dry period.

These cows were significantly less likely to achieve cure IMI as a result of the presence of *Corynebacterium spp.* (Huxley et al. 2002).

Some of these relationships are potentially explained by other findings and inferences from other authors. For example Williamson et al. (1995) found that fewer quarters treated with antibiotic dry cow therapy had open teat canals during the first 4 weeks of the dry period; this being a known risk period for new IMI (Bradley & Green 2004; Williamson et al. 1995). Quarters found to have open teat canals had the greatest prevalence of infection and therefore higher rates of CM and elevated SCC in the next lactation. It was proposed the use of dry cow therapy hastened development of the keratin plug, thereby increasing protection at this time (Williamson et al. 1995). This relationship may be due to the known keratinolytic properties associated with *Corynebacterium spp.* (Bradley & Green 2004). This is also possibly supported by the finding that only 20% of teats not receiving antibiotic dry cow therapy in organic herds form a teat seal by the late dry period (Hayton 2003). Antibiotic dry cow therapy possibly removes *Corynebacterium spp.* and hastens the development of the keratin plug seal essential to prevent IMI (Bradley & Green 2004).

6.2.10.6 Degree of Shedding

Log SCC prior to drying off has been shown to be significant in predicting the cure IMI of *Staphylococcus aureus*. As SCC increased the probability of cure at the cow level was shown to decrease (Sol et al. 1994).

Shedding assessed via the number of colony forming units was also significantly associated with the likelihood of cure at the cow level and there was also a significant relationship based on an interaction of shedding by the number of positive quarters (Dingwell et al.

2003). This was suggested to highlight that a reduction in shedding for each individual quarter results in an improvement in the probability of cure IMI.

6.2.10.7 Position

Teat position within the udder is likely to have an influence on the risk of new IMI or cure IMI. This being due to differences in yield seen between the front and rear quarters, with rear quarters known to have significantly higher milk yields, longer unit on times time, higher peak and average flow rates than front quarters (Tančin et al. 2006). This would subsequently be expected to translate into increased quarter risk. Hindquarters have been shown to be more likely to be infected at drying off, less likely to achieve cure IMI and be more likely to develop new IMI during the dry period (Natzke et al. 1975).

Cows with a major pathogen infection in the right hind quarter prior to drying off have been found to be significantly more likely to fail to cure IMI across the dry period as measured by the presence of a major pathogen early in the next lactation (Osterås et al. 1999). This was a significant association with $P \leq 0.001$ and for the left hind and left front $P \leq 0.01$, though the right front only had a tendency. Hindquarters were also found to carry twice the level of infection as front quarters. Osteras et al. (1999) also reference Barkema et al. (1995) findings were hindquarters had greater levels of infection than front quarters.

Descriptive analysis has also found that quarter positioning has an effect on the likelihood of cure IMI of *Staphylococcal aureus*. Front quarters were found to have a 72.3% cure rate compared to 61.5% for hind quarters (Sol et al. 1994). The proportion of quarters infected with *Staphylococcal aureus* has found to be higher for hind quarters than front quarters (53% cf. 47%). In a multivariable model front quarters were significantly more likely to cure IMI. Whilst no explanation of the cause of this finding was indicated by the authors, they

noted the numerous findings of the risk factor might warrant further investigation (Dingwell et al. 2003).

Quarters within a cow are unlikely to behave independently as they are not truly independent with blood flow being possible between them. In addition, there will be the possibility of transmission between quarters outside and within the parlour (Green et al. 2002). Quarters within the same cow are much more likely to mirror each other in terms of the pattern of infection and/or CM occurrence than two quarters from different cows (Green et al. 2002).

It has also been proposed that IMI may exist more commonly in specific quarters due to laterality, meaning that cows might prefer lying on a specific side. This could result in an increased likelihood of IMI on this side or compromise of blood flow/supply resulting in an increased risk of IMI (Osterås et al. 1999).

6.2.10.8 Number of quarters

The probability of cure IMI of an infected quarter (*Staphylococcal aureus)* decreased when another quarter was infected within the same cow. In addition an increasing number of positive samples prior to drying off was associated with a reduced likelihood of cure across the dry period and as previously indicated may suggest either level of shedding being an important factor or the number of quarters being infected (Sol et al. 1994). However, these findings were from the descriptive analysis. The final multivariable model highlighted when more than one quarter was infected with *Staphylococcal aureus,* it significantly influenced the likelihood of cure IMI, with cows meeting this criteria being less likely to cure than cows with one infected quarter (Sol et al. 1994).

The risk of failure of cure IMI across the dry period has been shown to be significantly increased both by the average number of quarters with a major pathogen infection and positive CMT and average number of quarters with *Staphylococcal aureus* isolates (Osterås et al. 1999).

A later descriptive summary of data for cure IMI (*Staphylococcal aureus)* across the dry period, found cure IMI to be the highest in cows that had three quarters affected (83.3%). The percentage of cows that cured with one, two or four quarters infected were 65.6%, 46.8% and 50% respectively. However, these differences were not found to be significant (Dingwell et al. 2003). The final multivariable model highlighted a significant association between the number of culture positive samples prior to drying off with the probability of cure IMI. This likely indicates that either magnitude of shedding or the number of infected quarters will play a role in the likely of the clearance of infection at this time (Dingwell et al. 2003). However, this significant association at the quarter level was not carried forward into the model looking at cure IMI at the cow level; suggesting this was not significant.

6.2.10.9 Clinical Mastitis

The presence of clinical mastitis in the lactation preceding the dry period has been found to be associated with SCC performance during the dry period.

Quarters entering the dry period infected were much more likely to have succumbed to a case of clinical mastitis in the previous lactation. Those quarters failing to cure during the dry period having a greater likelihood of experiencing a future case of CM than those infected and curing across the dry period (Pantoja et al. 2009b). In the final multivariable model, quarters with no occurrence of CM in the previous lactation had a significantly reduced odds of CM in the first 120 days of the lactation. Those quarters which had at least

one case of CM in the previous lactation were 4.2 times more likely to have a first case in the first 120 days of the next lactation. This despite the most commonly associated pathogens isolated from clinical mastitis being of Gram negative origin and therefore less likely to result in prolonged persistent infections (Pantoja et al. 2009b). This was a single herd study and therefore results could be interpreted with caution.

In a more recent study in two Floridian dairy herds, the univariable anlaysis highlighted a significant effect of CM in the last 60d of the previous lactation on the risk of positive bacteriological culture at both dry off and calving (Pinedo et al. 2012). In addition, finding CM in the previous lactation was significantly asscoiated with the risk of CM in the first 60d after calving as was clinical mastitis in the last 60d of the previous lactation (Pinedo et al. 2012). CM in the last 60d of the previous lactation was significantly associated with subclinical mastitis in the first 30d and 60d after calving (Pinedo et al. 2012).

In contrast treatment for chronic and acute CM at the cow level in the previous lactation were shown to have no significant association with the likelihood of failure of cure IMI (Osterås et al. 1999). However, at a herd level there was a tendency for these variables to be important predictors of the risk of failure of cure IMI. The final multivariable models witin this study found that acute CM in a previous lactation was a significant predictor of failure to cure IMI when bacteriology was not included in the model (Osterås et al. 1999).

6.2.11 Dry Cow Therapy

6.2.11.1 Antibiotic dry cow therapy

A number of UK based studies have highlighted the efficacy of a number of commonly used antibiotics utilised to effect cure across the dry period (Table 2).

Antibiotic	CPS	SUB	DYS	CNS	CORY
Cloxacillin (Newton et al 2008)	90	97	100	77	94
Cloxacillin (Berry and Hillerton 2002)	75	100	67	72	86
Cephalonium (Bradley et al 2010)	93	100	96	71	89
Cefquinome (Bradley et al 2011)	100	100	100	73	88

Table 2. Table highlighting the bacteriological cure rates, which have been achieved against commonly found pathogens in four UK based studies. CPS - Coagulase positive staphylococci, SUB - Streptococcus uberis, DYS - Streptococcus dysgalactiae, CNS – Coagulase negative staphylococci & CORY – Corynebacterium bovis (Breen et al. 2014).

Dry period cure rates when determined using bacteriology are high, but significant variation exists between herds and this is evident in the graph below (Madouasse et al. 2010).

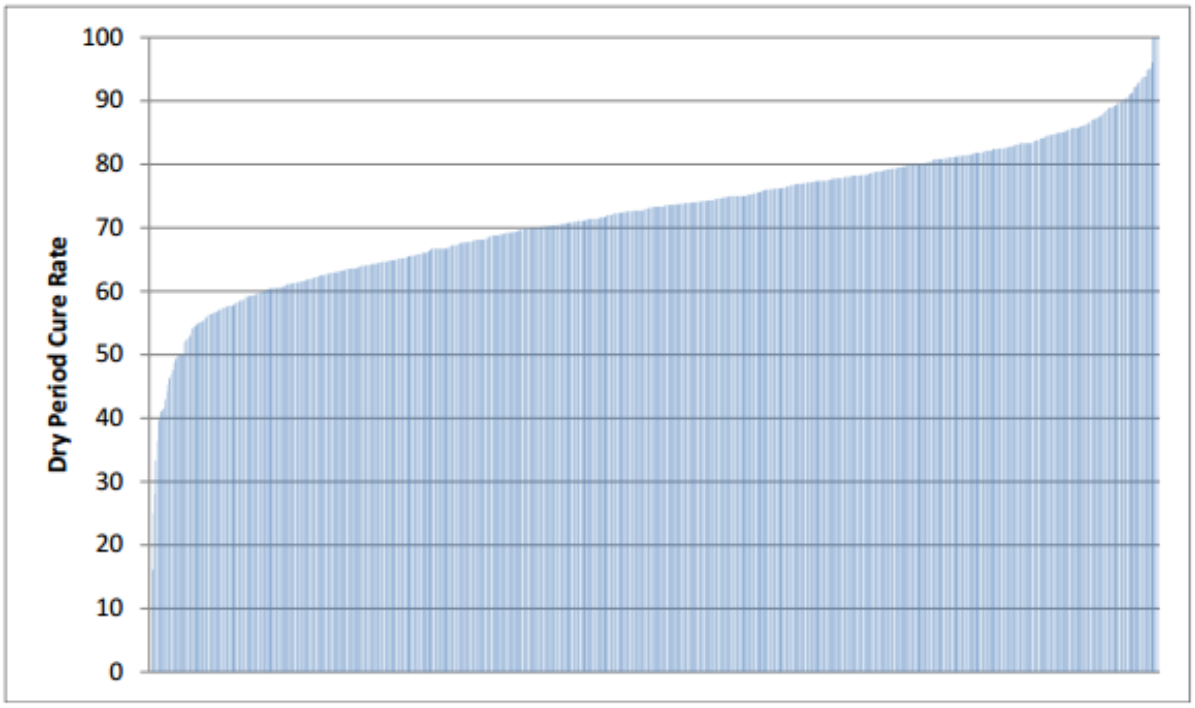


Figure 2. Distribution of dry period cure rate (<200,000 cells/ml at 1st test day) for herds enrolled on the DMCP 2009 – 2011 (Bradley et al. 2012).

Disparity in the bacteriology and SCC figures (Figure 2) is the result of new intramammary infections acquired across the dry period resulting in apparent failure of cure rather than true failure of cure. Less than 1.9% of major pathogen infections present at drying off have been shown to be present post calving (Bradley et al. 2011). A clear relationship has been highlighted whereby herds with the highest apparent cure rates tends to have the lowest new infection rates (Madouasse et al. 2012; A J Bradley, Green, et al. 2012).

As a result of the evidence highlighted there is no justification for the supplementation of dry cow therapy with systemic antibiotic treatments i.e. Tilmicosin (Nickerson et al. 1999; Wang et al. 2012).

A more favourable route to improve dry period cure rates would be to investigate failure in both cow and herd level management of the dry period with particular focus on areas as such environmental hygiene (Green et al. 2007; Green et al. 2008).

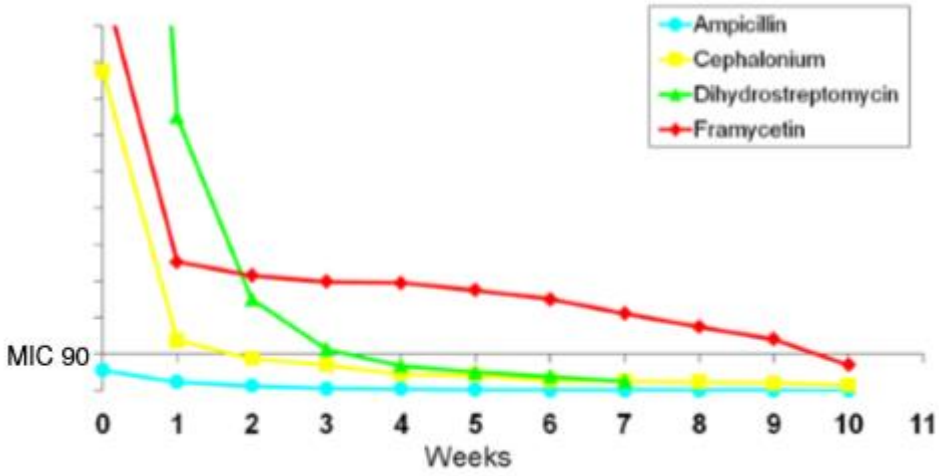


Figure 3. A graph demonstrating the time spent above MIC 90 for a number of commonly used antibiotics used in dry cow preparations (Green et al. 2016).

Figure 3 indicates the majority of ADCT does not maintain a level above MIC (minimum inhibitory concentration) 90 beyond 3 weeks. The only product highlighted in Figure 3 being framycetin. Framycetin is present within Ubro Red and this has a label claim for persistence above MIC for Escherichia coli for up to 14 weeks pots drying off (Bradley & Green 2001b). Ubro Red (Boehringer Ingelheim, Bracknell, UK) when compared to Orbenin Extra has been shown to achieve a 53% reduction in clinical coliform mastitis in the next lactation up to 100 days in milk and during the dry period, be no more likely to develop non coliform mastitis and no difference in SCC across the dry period (Bradley et al. 2011). Cefquinome (Cephaguard Dry Cow, Virbac Ltd., Bury St Edmunds, UK) is known to be effective against G+ ve and G-ve pathogens during the dry period. It can achieve high cure rates (See Table 2) and has also been shown to control new IMI in the dry period (Bradley et al. 2011).

	Gram +ve bacteria	B-lactamase S aureus	Gram -ve bacteria
Penicillins/penathamate	+++	-	-
Ampicillin	++	-	+
Cloxacillin/nafcillin	+++	+++	-
Cephalonium	++	++	++
Dihydrostreptomycin	+	++	+++
Framycetin/neomycin	++	++	+++

Table 3. The spectrum of activity of a number of antibiotics used commonly as part of dry cow therapy preparations (Bradley et al. 2003).

6.2.11.2 Combination dry cow therapy (CDCT)

This is the most widely practiced approach to DCT in the UK currently (P M Down, Bradley, Breen, Hudson, et al. 2016a). A number of studies have highlighted the effectiveness of this

approach (Godden et al. 2003; Newton, Green, Benchaoui, Cracknell, Rowan & A. J. Bradley 2008). However, protection against new IMI from coliforms is not provided (Halasa, Osterås, et al. 2009).

6.2.11.3 Selective Dry Cow Therapy (SDCT)

Recent research by Halasa et al. (2009) highlighted that blanket ADCT was protective against new IMI though gave no protection against new IMI due to coliforms. When selection was made at the cow level, SDCT provided protection against new IMI as well as BDCT and had similar efficacy at curing new IMI. When considering disruption of the mammary microbiome research by Oikonomou et al. (2014) looks at the population of bacteria in uninfected quarters. They suggested that the optimal bacterial population exists at a SCC value of between 21,000 – 50,000 cells/ml and that disruption could have negative consequences.

6.2.11.4 Selecting Treatment

Bacterial culture or the use the California Mastitis Test (CMT) at or before drying-off has been associated with false positives (poor specificity) and poor positive predictive value (Bhutto et al. 2012; Cameron et al. 2013).

Studies applying a selective approach have tended to use (Bradley et al. 2010) the last three somatic cell counts of a lactation and the absence of clinical mastitis in the last three months to define infection. This is a practical and cost-effective approach and the rate of misclassification will be relatively low (Bradley et al. 2003). The presence of a major pathogen at drying off is not a major concern for the occurrence of clinical mastitis or death following infusion with a teat sealant alone (McDougall & Compton 2015).

Nearly 60% of herds taking part in the AHDB Mastitis Control Plan have been found not to be selecting dry cow therapy at the cow level (P M Down, Bradley, Breen, Hudson, et al. 2016a). This being despite evidence it can reduce total antibiotic usage on farm by up to 85% (Scherpenzeel et al. 2014). Not applying a selective approach may increase the relative proportion of clinical mastitis in the next lactation caused by G-ve pathogens (Bradley et al. 2010). Selection of dry cow therapy at the cow level has been shown to reduce the risk of clinical mastitis within the first 30 days after calving (Green et al. 2007).

SDCT has also been shown to be just as effective as BDCT when selected at the cow level in the protection against new intramammary infections across the dry period (Halasa, Osterås, et al. 2009). SDCT has been shown to achieve similar relative risk of cure of existing intramammary infections as BDCT (Halasa, Nielen, et al. 2009). The use of a teat sealant has been shown to reduce the incidence of clinical mastitis in the dry period and first 100 days of lactation and the new infections present at calving compared to a negative control (E. A. Berry & Hillerton 2002b). It has also been shown to reduce the incidence of new infections by all major pathogens compared to a positive control in the dry period (Huxley et al. 2002) and the risk of acquiring new IMI across the dry period the risk of clinical mastitis up to 100 days in the next lactation in a meta-analysis (Rabiee & Lean 2013).

6.2.11.5 Teat Sealants

A recent meta-analysis of the efficacy of teat sealants confirmed that the use of these along with ADCT or alone reduced the incidence of IMI compared with control groups (Rabiee & Lean 2013).

Since Huxley et al. (2002) findings that quarters administered teat sealant acquire significantly fewer IMI, their use has grown exponentially. However, due to the risks of poor

infusion technique and the need to both treat existing infections and prevent new IMIs the majority of herds now perform combination therapy. This approach has been shown to work effectively (Godden et al. 2003; Newton, Green, Benchaoui, Cracknell, Rowan & a J. Bradley 2008).

7 Materials and Methods

7.1 Data

This retrospective cohort study comprised a large convenience sample of anonymized milk recording data collected by a milk recording organisation (Quality Milk Management Services [QMMS], Easton, UK) in the UK between September 1994 and July 2014. Herds milk recording with QMMS are predominantly located in the South West of England, though are GB wide. Herd size ranged from an minimum, median, mean and maximum of 65, 134, 161 and 659, respectively (See Figure 4). All farms undertook milk recording on a monthly basis.

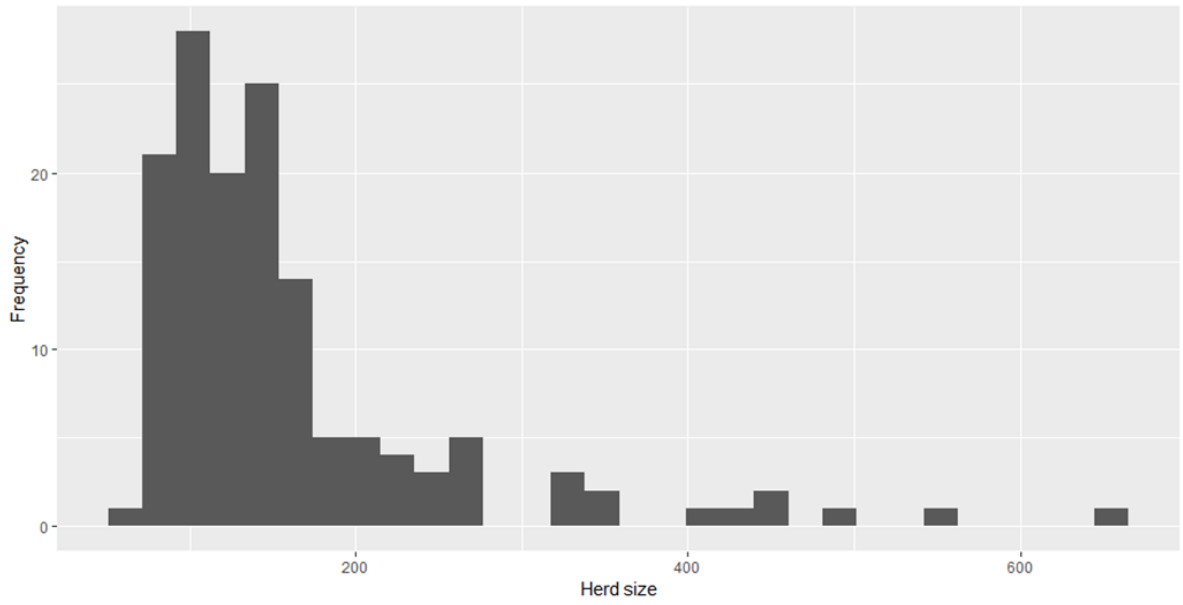


Figure 4. A figure highlighting the size of herds and their frequency in the dataset used for analysis.

Data was exported from a central server at QMMS for each individual herd (n = 158) included in the preliminary dataset. This preliminary dataset included a wide range of data including all health events/action recorded for each individual cow within each herd including operator, comments, Johne's milk test results, milk yield, SCC, butterfat, protein, date of birth, individual identification, line number, breed, current status, date of entry onto farm, date off farm, dam ear tag and sire ear tag.

This data was then sorted was using Microsoft Access 2010 (Microsoft Corporation, Redmond, Washington) by running a number of queries using the Tables with the Access database described as bovines, bovine actions, bovine milk analysis and bovine johns analysis. Queries were created and run on the raw data to gather information, which was defined important to achieve the preliminary objectives of the study.

The queries ran included animal/date/SCC, previous calving date, clinical mastitis, full list of actions, SCC > 200,000 cells/ml, SCC > 400,000 cells/ml, SCC > 600,000 cells/ml, Maximum SCC, Minimum SCC, Somatic Cell Counts 0 – 30 days, 31 – 60 days and 61 – 90 days, 91 - 120 and 121 – 150 days pre-drying off, standard deviation of SCC, lactation length, lactation ID, SCC variation, SCCs per lactation, dry off dates, first recording dates, number of lactations per cow, clinical mastitis prior to 30 days in milk, clinical mastitis count per lactation, lactations with 6 – 20 SCC recordings and SCC recording dates. SCC categories were also created for up to three prior lactations also. Lactations were only included in the data set if they had at least 6 test days per lactation (including first test day and at least monthly herd tests for the last 5 months prior to drying off) and the first test day of the next lactation (to allow assessment of dry period infection status).

The final data set was then prepared for statistical analysis using Microsoft Excel 2010 (Microsoft Corporation, Redmond, Washington). The data were checked and test days with missing values were recorded as 'missing' to allow removal during analysis. Further ordering of data was undertaken including numbering each level of data, each farm, each animal and each individual lactation. The data was examined highlighting that only the previous lactation would be available to analyse as prior lactations were screened out due to the many previous criteria mentioned above. We felt losing this data was appropriate to do the analysis we wanted to carry out whilst still having a relatively large dataset to work from. However, no records were kept to detail the number of records that were lost for each of the inclusion criteria.

The categories for SCC recordings prior to drying off were examined and if two recordings occurred within a single one of these time frames, then the one closest to drying off was used. The first test day of the next lactation was selected to occur at less than 40 days in milk; if two recordings occurred within this interval the one closest to calving was taken. The final data set included records of 46,257 lactations from 24,570 cows in 114 herds.

A SCC < 200,000 cells/mL was classified as "uninfected" and SCC ≥ 200,000 cells/mL classified as "infected" (McDermott et al. 1982; Dohoo & Leslie 1991; Schepers et al. 1997). The proportion of test days infected in any one lactation was calculated from the number of test days infected divided by the total number of test days in the lactation. Lactations were then categorised into a variable comprising the proportion of test days infected in each lactation, using the following categories; 0%; 1 to 25%; 26 to 50%; 51 to 75%; 76 to 100%. These categories were also applied to lactations to evaluate the influence of the magnitude of SCC. The thresholds of > 199,000 cells/ml, > 399,000 cells/ml and > 599,000 cells/ml were

used within which these categories were also applied. It was felt categorising the proportion of a lactation spent “infected” above differing thresholds and “uninfected” was the simplest way to highlight particularly for “infected” individuals how chronicity of infection might influence failure to cure IMI.

The maximum of the last five test days SCC recording was also grouped into a categorical variable using the following categories; 0 – 20,000 cells/ml; 21 – 30,000 cells/ml; 31 – 50,000 cells/ml; 51 – 70,000 cells/ml; 71 – 90,000 cells/ml; 91 – 150,000 cells/ml; 151 – 199,000 cells/ml; ≥ 200,000 cells/ml. This categorisation was created with the aim to investigate if there were associations with very low SCC prior to drying off and an increased likelihood of new IMI during the dry period. Parity was categorised in groups of 1, 2, 3, 4 and 5 (being inclusive of 5^{th} – 16^{th} parity).

Dry periods were classified as eligible for new infection depending on the last SCC prior to drying off; SCC < 200,000 cells/ml and eligible for cure; SCC ≥ 200,000 cells/ml. Binary variables were created to represent the outcome for each dry period: for dry periods eligible for a new infection, the outcome was either ‘1’ (where the first test day had a SCC ≥ 200,000 cells/ml) or ‘0’ (where the first test day had a SCC < 200,000 cells/ml). For dry periods eligible for cure, the outcome was classified as a ‘1’ (where the first test day had a SCC < 200,000 cells/ml) or ‘0’ (where the first test day had a SCC ≥ 200,000 cells/ml).

Two multi-level (random effects) logistic regression models were created for Cure IMI and New IMI instead of one model. This was done as it was felt this would be easier to build, interpret and more widely understood.

7.2 Descriptive Analysis

An exploratory analysis of the data was carried out to identify patterns within the data that would highlight the distributional characteristics unique to this dataset. Descriptive statistics was performed using Microsoft Excel 2010 (Microsoft Corporation, Redmond, Washington) to allow simple investigation of a range of variables and reporting of maximum, minimum, median, modal and interquartile range for a range variables.

R (R Core Team 2015) was utilised to plot these distributional characteristics for some of the main variables of interest. These included whole distribution plots of parity, lactation per farm, days in milk at drying off, dry period length and milk yield at drying off. The latter three variables included maximum, minimum, median and interquartile range in the form of box and whisker plots (Figure 7, 8 & 9).

7.3 Statistical Analysis

7.3.1 Model 1: Probability of Cure of IMI

A multi-level (random effects) logistic regression model was constructed for the outcome variable cure IMI to explore the associations between this outcome and historical cow-level variables (Table 2). A 3 level random effects model with lactations nested within cows nested within herds was used. The model took the form:

$$\text{CureIMI}_{ijk} \sim \text{Bernoulli (mean} = \pi_{ijk})$$

$$\text{logit}(\pi_{ijk}) = \alpha + \beta_1 X_{ijk} + \beta_2 X_{jk} + u_{jk} + v_k \quad (1)$$

$$u_{jk} \sim N(O, \sigma_u^2) \quad (2)$$

$$v_k \sim N(O, \sigma_v^2) \quad (3)$$

Where the subscripts *i*, *j* and *k* represent the *i*th cow lactation in the *j*th cow in the *k*th herd, respectively. π_{ijk} was the probability of cure IMI for the *i*th cow lactation in the *j*th cow of the *k*th herd. α was the model intercept, X_{ijk} and X_{jk} predictor variables at lactation and cow level and $\beta_1$and β_2 the coefficients for X_{ijk} and X_{jk}, u_{jk} was a random effect to account for the residual variation between cows within herds and v_k the residual variation between herds (both assumed to be normally distributed with mean = 0 and variances = σ_u^2 and σ_v^2 respectively).

Univariable analysis was utilised to check the significance of variables for inclusion in the model initially. The model was built using a forward selection or stepwise procedure. Variables significant in the univariable analysis were included first and then those that were not, with the retention of variables that were deemed significant (95% credible intervals for the odds ratio did not include 1). Polynomials for continuous predictor variables were tested to evaluate non-linear relationships and were retained in the model when significant.

Potential Predictor Variable	Variable Type
Proportion of prior lactation > 199,000 cells/ml	Categorical
Proportion of prior lactation > 399,000 cells/ml	Categorical
Proportion of prior lactation > 599,000 cells/ml	Categorical
Proportion of lactation prior to current > 199,000 cells/ml	Categorical
Proportion of lactation prior to current > 399,000 cells/ml	Categorical
Proportion of lactation prior to current > 599,000 cells/ml	Categorical
Parity	Categorical (1, 2, 3, 4, ≥5)
Milk Yield at last test day (kilograms)	Continuous
Lactation Length (days)	Continuous

Dry Period Length (days)	Continuous
SCC at last test day (100,000 cells/ml)	Continuous

Table 4. Model 1: Potential predictor variables tested in the cure of IMI model predictor variables tested in the cure of IMI model.

1 Parity ≥5 = includes parity 5 – 16, 2 Proportion of prior lactation = the lactation in which is cow is being dried off, 3 Proportion of lactation prior to current = the lactation before the one in which the cow is being dried off.

Initial model building was carried out in MLwiN version 2.32 (Rabash et al. 2015). Final parameter estimates were made in a Bayesian framework using Markov chain Monte Carlo (MCMC) with a burn-in chain length of 5,000 iterations and a monitoring chain length of 50,000 iterations.

Posterior predictions (Gelman et al. 1996) were used to examine model fit and illustrate differences in expected cure rates between different subsets of cows. The model was used to generate separate lines of data e.g. parity and then the subsets of data were used to check that our predicted cure was comparable to the actual cure. This was first visually assessed and a chi squared test was then used to check there were no significant differences between the prediction and the actual outcome value. Others methods such as Hosmer–Lemeshow test could have been used. Model fit was found to be poorer with cow level random effects included and therefore final models consisted of a two level structure without the cow level random effects i.e. cow lactations within herds. MCMC chains for each parameter were visually assessed for convergence.

An error made in the initial analysis failed to screen out dry periods longer than 100 days. These were excluded and the analysis performed again. This did not change what was already found to be significant in the model or the direction of associations with coefficient estimates remaining very similar.

7.3.2 Model 2: Probability of New IMI

A multi-level logistic regression model was specified for cows eligible for a new IMI (Table 3). The approach to modelling was the same as that described for Model 1 with the final model consisting of a two level structure except the binary outcome was either new infection (= 1) or not (= 0).

Potential Predictor Variable	Variable Type
Proportion of lactation prior to current > 199,000 cells/ml	Categorical
Parity	Categorical (1, 2, 3, 4, ≥5)
Milk Yield at last test day (kilograms)	Continuous
Lactation Length (days)	Continuous
Dry Period Length (days)	Continuous
Max SCC of last 5 test days	Categorical

Table 5. Model 1: Potential predictor variables tested in the cure of IMI model predictor variables tested in the cure of IMI model.

1 Parity ≥5 = includes parity 5–16. 2 Maximum SCC of last 5 test days = the categorized maximum SCC of the last 5 test days before drying off.

An error made in the initial analysis failed to screen out dry periods longer than 100 days. These were excluded and the analysis performed again. This did not change what was already found to be significant in the model or the direction of associations with coefficient estimates remaining very similar.

8 Results

8.1 Descriptive Results – All data

The final data set used for analysis comprised 46,257 lactations, 24,570 cows and 114 herds. The median days in milk (DIM) at drying off was 326 (interquartile range; IQR 295 – 379), the median dry period length (DPL) was 58 days (IQR 48 - 73) and the median milk yield (MY) in the month before drying off was 14 kg (IQR 9.8 – 18.5). The median parity group was 3 (IQR 2 – 5) with the modal parity group being 2. The median number of lactations per farm was 280 (IQR 75 – 580) (Figure 5).

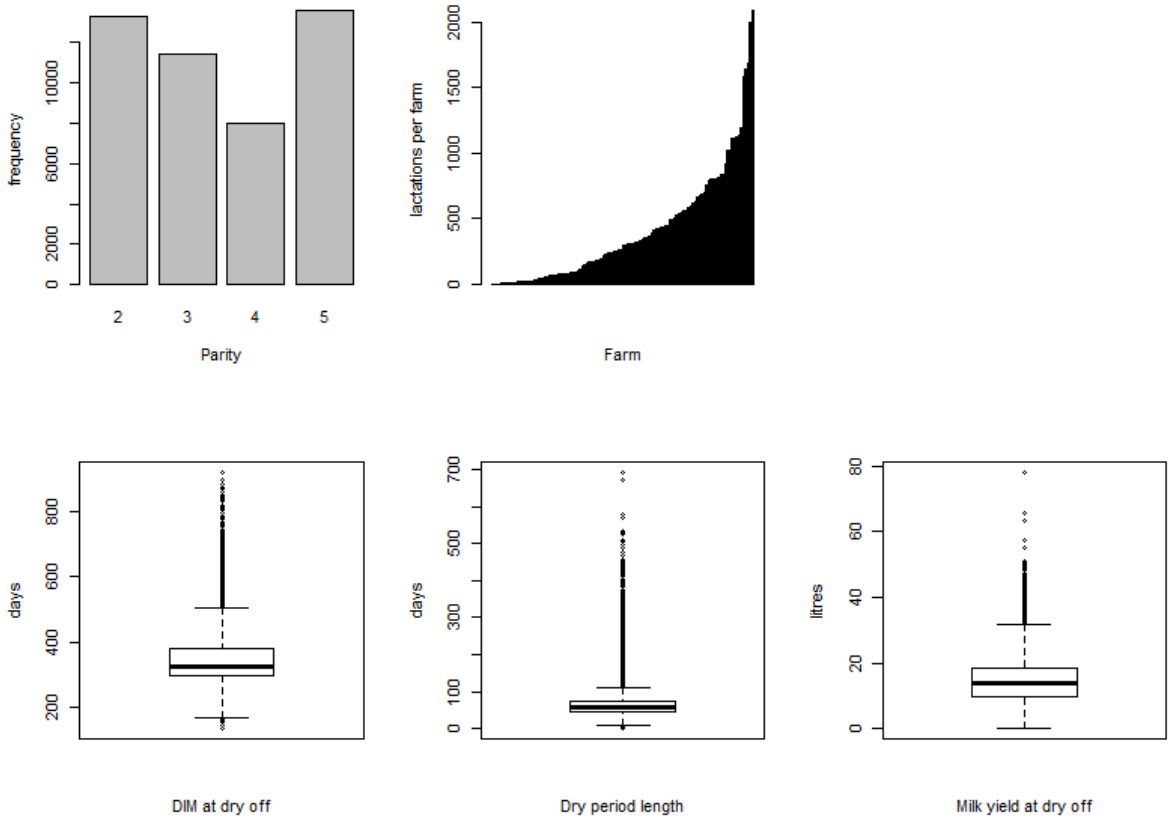


Figure 5. Descriptive results (all data): Distribution of a selection of variables including frequency of each parity, number of lactations per farm, DIM, dry period length (d), and milk yield at drying off (kg) from the 46,257 lactations from 24,660 cows in 114 herds between September 1994 and July 2014.

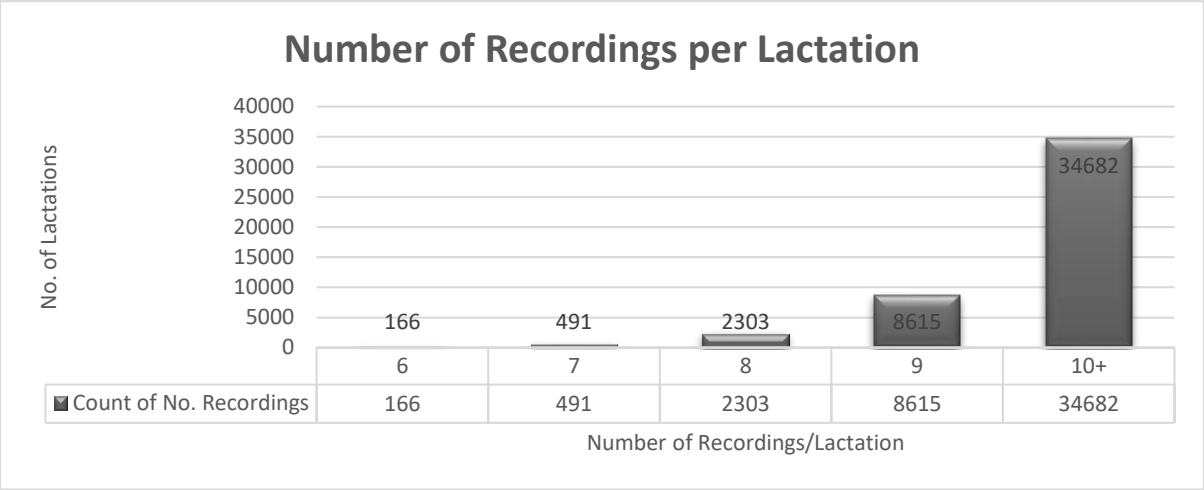


Figure 6. Descriptive results (all data): Distribution of the number of recordings per lactation. A minimum of 6 recordings per lactation being required prior to being included in the analysis.

The median number of test days (recordings) per lactation was 11 (IQR 9 – 12) with the modal number of test days per lactation being 10 (Figure 6).

	SCC 121-150 days pre DO	SCC 91 - 120 days pre DO	SCC 61 – 90 days pre DO	SCC 31 - 60 days pre DO	SCC 0 -30 pre days DO	Mean SCC of the last 5 test days	1st test day of next lactation
Minimum	1	1	1	1	1	8	1
25th centile	37	44	51	61	79	69	27
Median	74	87	101	120	164	131	58
75th centile	158	180	204	244	342	256	169
Maximum	9999	9999	9999	10303	10168	5607	11869
Mean	179	192	207	236	331	229	270

Table 6. Descriptive results (all data): The minimum, 25th centile, median, 75th centile, maximum and mean of SCC at each of the last 5 test days prior to drying off, for the maximum SCC across the last 5 test days and the 1st test day of the next lactation.

The median SCC of the last test day prior to drying off, of the mean SCC of the last 5 test days prior to drying off and the 1st test day of the next lactation was 164,000 cells/ml (IQR 79,000 – 342,000 cells/ml), 131,000 cells/ml (IQR 69,000 – 256,000 cells/ml) and 58,000 cells/ml (IQR 27,000 – 169,000 cells/ml), respectively (Table 6).

Of the 46,257 lactations within the dataset, 20,109 lactations were eligible for cure at drying off and 26,148 lactations were eligible for a new infection at drying off. Therefore, 57% of the lactations were uninfected at last test day and 43% were infected at last test day prior to drying off. A total of 10,574 lactations were infected at first test day following the dry period meaning 23% of 1st test days were infected in the subsequent lactation.

8.2 Descriptive Results – Cows eligible for cure IMI

Cows eligible for cure IMI originated from all 114 herds and data was available for 20,109 lactations from 13,039 cows with 14,253 lactations from 10,170 cows achieving cure IMI and 5,856 lactations from 4,397 cows failing to cure IMI. The median number of lactations per farm was 128 (IQR 30 – 226) (Figure 7).

The median DIM at drying off was 333 (IQR 299 - 392) for all eligible lactations. The group achieving cure IMI, had a median DIM at drying off of 332 (IQR 299 - 390) and this showed little difference from the group failing to achieve cure IMI, which had a median of 338 (IQR 300 – 400). The median DPL was 61 days (IQR 50 – 83). The subset of dry periods achieving cure IMI had a median DPL of 61 days (IQR 50 – 81) with the group failing to cure IMI being

Percentage of Lactation >= 200,000 cells/ml	Percentage of Lactations >= 200,000 cells/ml
3 – 25	40
26 – 50	31
51 – 75	17
76 - 100	12
Percentage of Lactation >= 400,000 cells/ml	Percentage of Lactations >= 400,000 cells/ml
0	28
3 – 25	47
26 – 50	16
51 – 75	6
76 – 100	3
Percentage of Lactation >= 600,000 cells/ml	Percentage of Lactations >= 600,000 cells/ml
0	46
3 - 25	40
26 – 50	10

51 – 75	3
76 - 100	1

Table 7. Descriptive results (cows eligible for cure): The percentage of lactations within the eligible for cure model which in the different categories of infection level at >= 200,000 cells/ml, 400,000 cells/ml and 600,000 cells/ml.

Percentage of Lactation prior to current >= 200,000 cells/ml	Percentage of Lactations >= 200,000 cells/ml
0	25
3 - 25	39
26 - 50	21
51 - 75	9
76 - 100	6

Table 8. Descriptive results (cows eligible for cure): The percentage of lactation prior to the current which are in the different categories of infection level at >= 200,000 cells/ml.

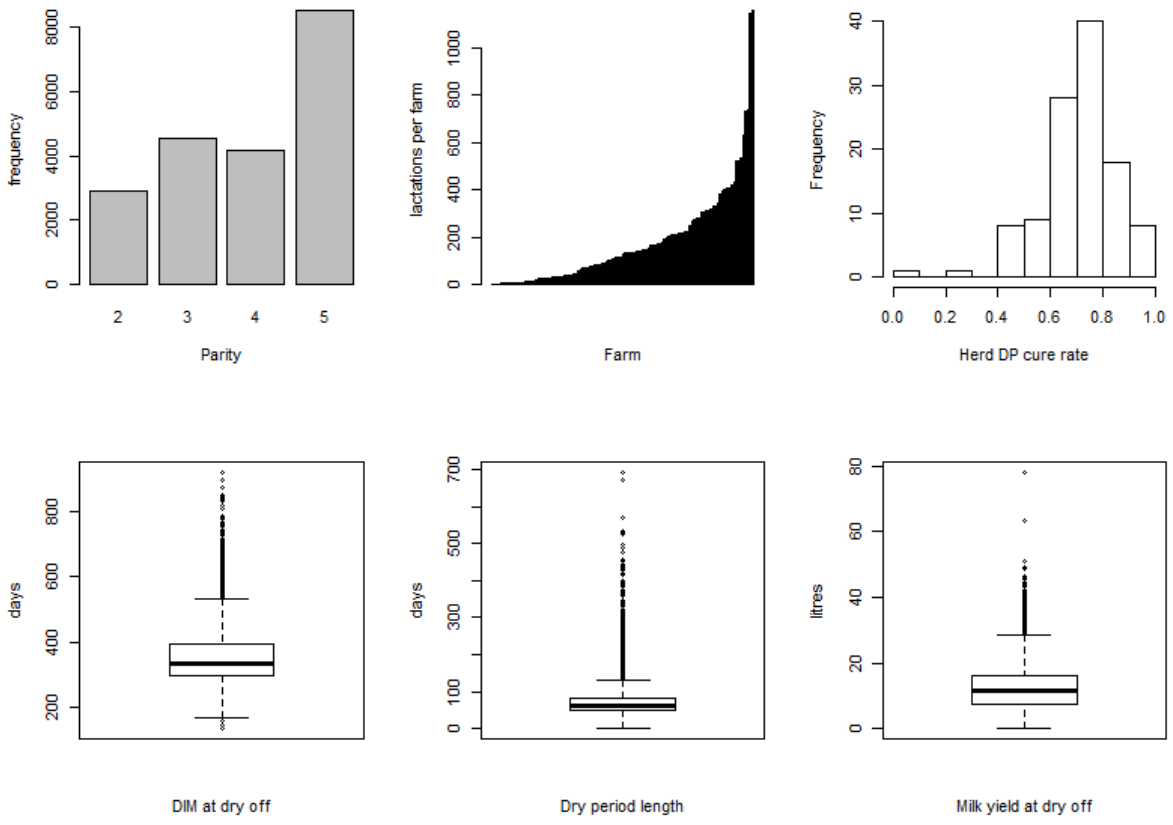


Figure 7. Descriptive results (cows eligible for cure): Distribution of a selection of variables including frequency of each parity, number of lactations per farm, DIM, dry period length (d), and milk yield at drying off (kg) and herd dry period (DP) cure rate from 20,109 lactations from 13,039 cows in 114 herds between September 1994 and July 2014.

similar with a median of 61 days (IQR 48 – 88). Those eligible for cure had a median MY of 11.4 kg (IQR 7.5 – 16.0), those achieving cure IMI had a median MY at dry off of 11.2 kg (IQR

7.2 – 15.8) and was very similar to those failing to cure IMI, which had a median of 11.7 kg (IQR 8.2 – 16.6).

The median parity group for those eligible for cure was higher than for those achieving cure IMI. Those eligible had a median of 6 (IQR 3 – 6) with the modal being parity group 3 and those achieving cure IMI had a median parity group of 4 (IQR 3 – 5), with the modal parity group being 3. Again this showed very little difference with those failing to achieve cure IMI which had a median of 4 (IQR 3 – 6) and mode of 3. The mean cure IMI across all herds was 71%, median 72% (IQR 66 – 79%).

	SCC 121-150 days pre DO	SCC 91 -120 days pre DO	SCC 61 – 90 days pre DO	SCC 31 - 60 days pre DO	SCC 0 -30 pre days DO	Mean SCC of the last 5 test days	1st test day of next lactation
Minimum	5.00	3.00	1.00	2.00	200.00	52.40	1.00
25th centile	70.00	87.00	107.00	144.00	273.00	175.40	34.00
Median	134.00	163.00	191.00	242.00	396.00	266.40	80.00
75th centile	266.00	322.00	346.00	428.00	671.00	453.60	254.00
Maximum	9999.00	9999.00	9999.00	10303.00	10168.00	5607.40	11869.00
Mean	276.17	303.98	332.39	405.52	653.53	394.32	350.48

Table 9. Descriptive results (cows eligible for cure): The minimum, 25th centile, median, 75th centile, maximum and mean of SCC at each of the last 5 test days prior to drying off, for the maximum SCC across the last 5 test days and the 1st test day of the next lactation.

The median SCC of the last test day prior to drying off, of the mean SCC of the last 5 test days prior to drying off and the 1st test day of the next lactation was 396,000 cells/ml (IQR 273,000 – 671,000 cells/ml), 266,000 cells/ml (IQR 175,000 – 453,600 cells/ml) and 80,000 cells/ml (IQR 34,000 – 254,000 cells/ml), respectively (Table 9).

8.3 Descriptive Results – Cows eligible for new IMI

Cows eligible for new IMI originated from all 114 herds and data was available for 26,148 lactations from 17,100 cows. The median number of lactations per farm was 156 (IQR 43 -

327) (Figure 8). The subset succumbing to a new IMI included 4,718 lactations from 3,883 cows and those remaining uninfected included 21,430 lactations from 14,701 cows. The eligible population had a median DIM at drying off of 321 (IQR 294 - 368). This was slightly longer for the subset acquiring a new IMI with a median DIM at drying off, of 326 (IQR 296 – 376), though shorter for those remaining uninfected, which had a median of 320 (IQR 293 – 366). No difference was evident in median DPL, with the group eligible for new IMI median DPL being 57 days (IQR 47 – 68), those acquiring new IMI having a median DPL of 57 days (IQR 45 – 69) and those remaining uninfected, which had a median of 57 days (IQR 48 – 68). Median MY at dry off showed very little difference with values of 15.9 kg (IQR 12.0 – 20.0), 16.1 kg (IQR 11.9 – 20.3) and 15.8 kg (IQR 12 – 19.9) respectively. The median parity group was 3 (IQR 2 – 4) with the modal being parity group 2 for the group eligible for new IMI (Figure 3), the median parity group was 3 (IQR 2 – 5) with the modal being parity group 2 for those acquiring new IMI and the median group was 3 (IQR 2 – 4) with a mode of parity group 2; again highlighting very little difference. The mean percentage of new IMI was 19%, median 18% (IQR 13 – 24%).

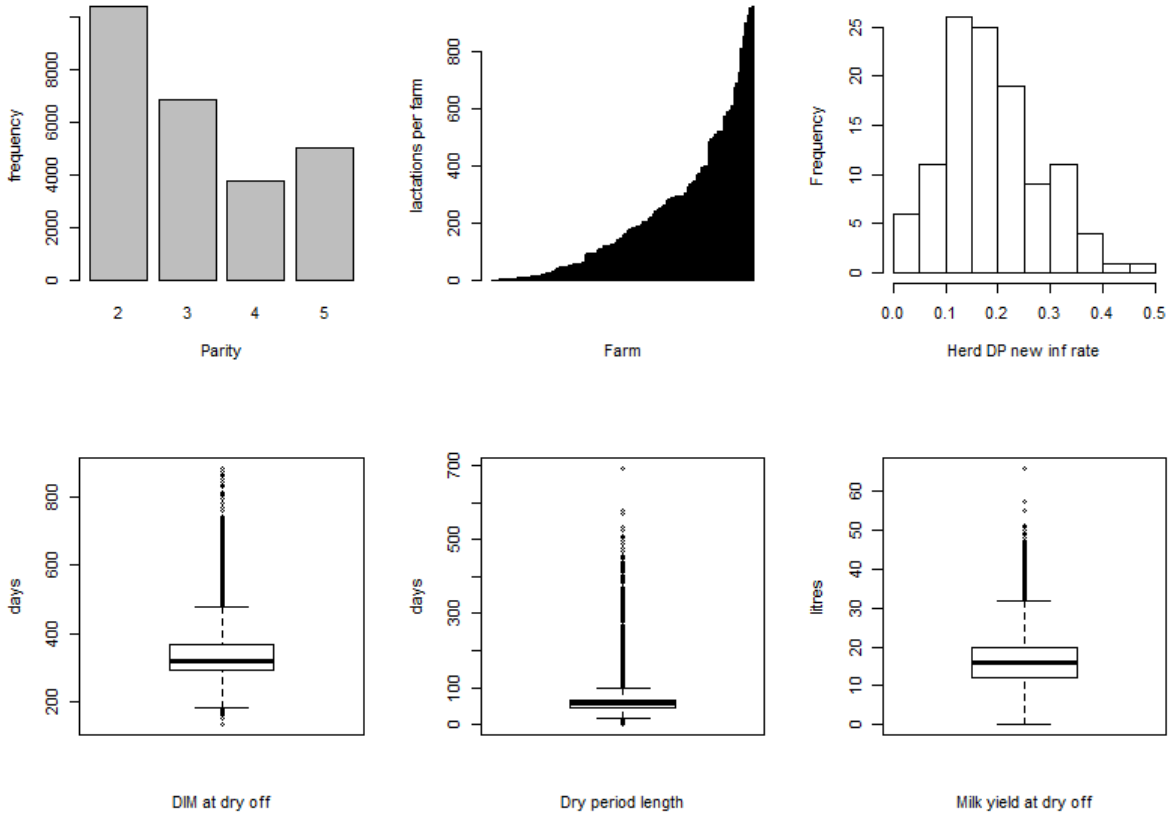


Figure 8. Descriptive results (cows eligible for new IMI): Distribution of a selection of variables including frequency of each parity, number of lactations per farm, DIM, dry period length (d), and milk yield at drying off (kg) and herd dry period (DP) new infection rate from 26,148 lactations from 17,100 cows in 114 herds between September 1994 and July 2014.

	SCC 121-150 days pre DO	SCC 91 -120 days pre DO	SCC 61 – 90 days pre DO	SCC 31 - 60 days pre DO	SCC 0 -30 pre days DO	Mean SCC of the last 5 test days	1st test day of next lactation
Minimum	1.00	1.00	1.00	1.00	1.00	8.20	1.00
25th centile	29.00	34.00	38.00	44.00	53.00	50.20	25.00
Median	52.00	59.00	67.00	77.00	89.00	79.40	51.00
75th centile	97.00	110.00	117.00	131.00	136.00	125.00	129.00
Maximum	9999.00	9999.00	8458.00	10303.00	199.00	3800.80	11512.00
Mean	107.93	118.93	113.29	135.11	95.72	114.19	210.44

Table 10. Descriptive results (cows eligible for new IMI): The minimum, 25th centile, median, 75th centile, maximum and mean of SCC at each of the last 5 test days prior to drying off, for the maximum SCC across the last 5 test days and the 1st test day of the next lactation. The median SCC of the last test day prior to drying off, of the mean SCC of the last 5 test days prior to drying off and the 1st test day of the next lactation was 89,000 cells/ml (IQR 53,000 – 136,000 cells/ml), 79,400 cells/ml (IQR 50,200 – 125,000 cells/ml) and 51,000 cells/ml (IQR 25 – 129,000 cells/ml), respectively (Table 8).

Percentage of Lactation prior to current >= 200,000 cells/ml	Percentage of Lactations >= 200,000 cells/ml
0	28
3 - 25	43
26 - 50	16
51 - 75	7
76 - 100	6

Table 11. Descriptive results (cows eligible for new IMI): The percentage of lactation prior to the current which are in the different categories of infection level at >= 200,000 cells/ml. The categories identified the proportion of recordings within a lactation which were classified as infected.

Max SCC of the last 5 test days	Percentage of Lactations
Max SCC of last 5 test days (0 - 20,000 cells/ml)	1
Max SCC of last 5 test days (21 - 30,000 cells/ml)	5
Max SCC of last 5 test days (31 - 50,000 cells/ml)	9
Max SCC of last 5 test days (51 - 70,000 cells/ml)	10
Max SCC of last 5 test days (71 - 90,000 cells/ml)	10
Max SCC of last 5 test days (91 - 150,000 cells/ml)	23
Max SCC of last 5 test days (151 - 199,000 cells/ml)	18
Max SCC of last 5 test days (> 199,000 cells/ml)	24

Table 12. Descriptive results (cows eligible for new IMI): The percentage of lactations which had a maximum SCC from the last 5 test days between each of the intervals identified in the table.

8.4 Statistical Modelling

8.4.1.1 Model 1: Cure of IMI.

The results of this model are presented in Table 13. The probability of cure in a cow was significantly reduced with an increasing proportion of the prior lactation individual SCC > 199,000 cells/ml and additionally reduced with an increasing proportion of the prior lactation individual SCC > 399,000 cells/ml. The odds of cure were more than two times higher (OR = 2.59, 2.22 – 3.03) if ≤ 25% of the previous lactation was > 199,000 cells/ml compared to a lactation when > 75% were > 199,000 cells/ml. The odds of cure was less than two times (OR = 1.30, 1.05 – 1.62) higher when ≤ 25% of the prior lactation individual SCC were > 399,000 cells/ml compared to when > 75% of SCC were above this value.

Model Term	Coefficient	Odds Ratio	95% Credible Interval
Intercept	0.227		
Proportion of prior lactation > 199,000 cells/ml (76 – 100%)			REFERENCE
Proportion of prior lactation > 199,000 cells/ml (51 – 75%)		1.26	1.11 – 1.45
Proportion of prior lactation > 199,000 cells/ml (26 – 50%)		2.17	1.88 – 2.51
Proportion of prior lactation > 199,000 cells/ml (3 – 25%)		2.59	2.22 – 3.03
Proportion of prior lactation > 399,000 cells/ml (76 – 100%)			REFERENCE
Proportion of prior lactation > 399,000 cells/ml (51 – 75%)		1.10	0.90 – 1.34
Proportion of prior lactation > 399,000 cells/ml (26 – 50%)		1.49	1.22 – 1.82
Proportion of prior lactation > 399,000 cells/ml (3 – 25%)		1.30	1.05 – 1.62
Proportion of prior lactation > 399,000 cells/ml (0%)		1.51	1.19 – 1.91
Proportion of lactation prior to current > 199,000 cells/ml (76 – 100%)			REFERENCE
Proportion of lactation prior to current > 199,000 cells/ml (5 –75%)		1.16	0.89 – 1.52
Proportion of lactation prior to current > 199,000 cells/ml (26 –50%)		1.33	1.05 – 1.69
Proportion of lactation prior to current > 199,000 cells/ml (3 – 25%)		1.37	1.09 – 1.72
Proportion of lactation prior to current > 199,000 cells/ml (0%)		1.99	1.56 – 2.53
Parity ≥5			REFERENCE
Parity 4		1.11	1.01 – 1.21
Parity 3		1.22	1.12 – 1.33
Parity 2		2.00	1.79 – 2.25
Milk Yield (kg) at last test day (per 10 Litres)		0.79	0.75 – 0.84
Lactation Length (per 100 days)		0.90	0.86 – 0.93
SCC at last test day (per 500,000 cells/ml)		0.97	0.95 – 0.99
Herd Level Variance ($\sigma_u^{2)}$	0.187		

Table 13. Model 1: Results of the multilevel logistic regression model for the probability of cure of IMI in an individual cow across the dry period.

1 Parity ≥5 = includes parity 5–16.

The probability of cure decreased as the proportion of SCC > 199,000 cells/ml in the lactation prior to the current one increased. The magnitude of this effect was greatest when comparing lactations with no SCC > 199,000 cells/ml to those with > 75% of SCC > 199,000 cells/ml (OR = 1.99, 1.56 – 2.53).

The odds of cure were two times as high in a parity two cow compared to a parity five plus cow (OR = 2.00, 1.79 – 2.25). Increasing milk yield at drying off was associated with a reduced probability of cure and similar effects on the odds of cure were seen with the explanatory variables lactation length and SCC at last test day before drying off.

Example predictions of cure probabilities are provided below to illustrate the variation in expected cures for three hypothetical groups of cows;

Group 1: 10% of prior lactation SCC > 199,000 cells/ml, 10% of prior lactation SCC > 399,000 cells/ml, no SCC in lactation prior to current > 199,000 cells/ml, parity = 3, milk yield at last test day prior to drying off = 15kg, lactation length prior to drying off = 305 days, SCC at last test day prior to drying off = 250,000: ***Predicted probability of cure across the dry period (95% credible interval) = 0.87 (0.83-0.92).***

Group 2: 30% of prior lactation SCC > 199,000 cells/ml, 30% of prior lactation SCC > 399,000 cells/ml, no SCC in lactation prior to current > 199,000 cells/ml, parity = 3, milk yield at last test day prior to drying off = 20kg, lactation length prior to drying off = 320 days, SCC at last test day prior to drying off = 700,000 cells/ml: ***Predicted probability of cure across the dry period (95% credible interval) = 0.81 (0.73-0.88).***

Group 3: 80% of prior lactation SCC > 199,000 cells/ml, 80% of prior lactation SCC > 399,000 cells/ml, 80% of lactation prior to current > 199,000 cells/ml, parity = 5, milk yield at last test

day prior to drying off = 25kg, lactation length prior to drying off = 350 days, SCC at last test day prior to drying off = 200,000 cells/ml: ***Predicted probability of cure across the dry period (95% credible interval) = 0.38 (0.13-0.75).***

These example groups were used to form comparisons of similar cohorts of cows from the actual data to assess the true proportion of cure IMI across the dry period and compare with the predicted probability of cure across the dry period. However, the subset size was too small to make these comparisons possible.

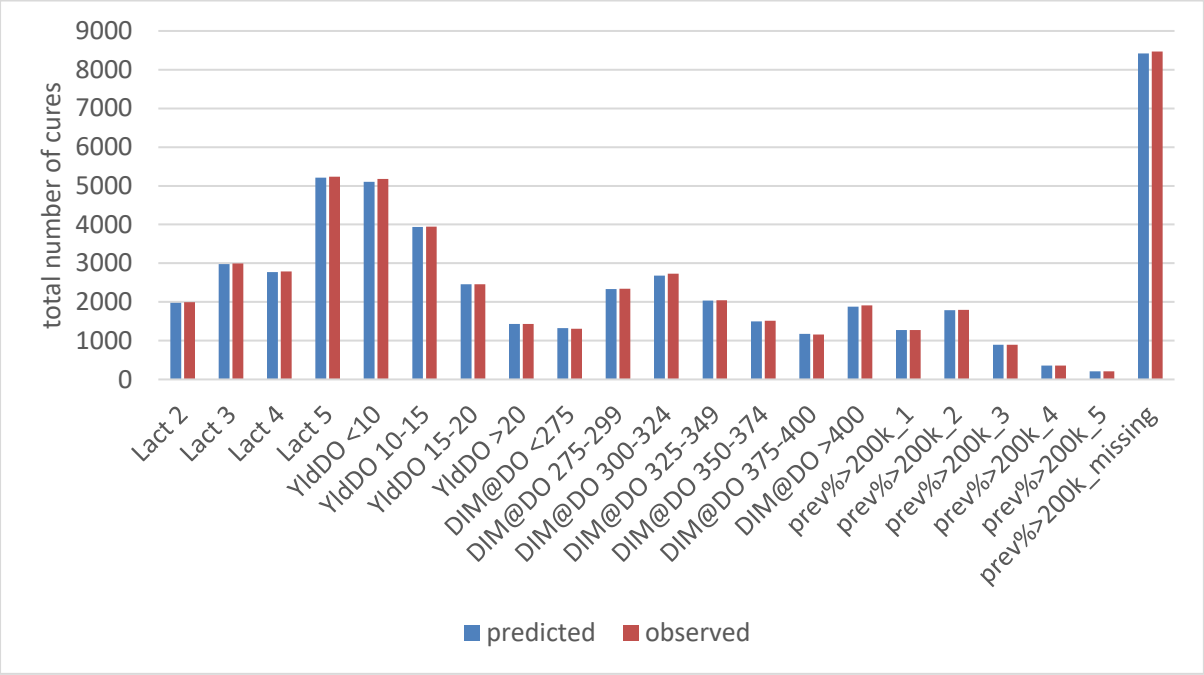


Figure 9 - Graph comparing predicted to observed values for Cure IMI.

Predictions for cure IMI were compared to observed outcomes and chi-squared tests had a p>0.05 for each group of subsets tested, indicating good model fit (Figure 9).

8.4.1.2 Model 2: new IMI.

The results of this model are presented in Table 14. The probability of new IMI in a cow was significantly increased as the proportion of SCC > 199,00 cells/ml in the lactation prior to the current one increased. The odds of new IMI were 0.51 times (CI 0.36 – 0.70) as likely if ≤25%

of the prior lactation was > 199,000 cells/ml and nearly 0.36 times (CI 0.26 – 0.50) as likely if no SCC > 199,000 cells/ml when compared to a lactation when > 75% of SCC > 199,000 cells/ml.

The odds of new IMI were 0.65 times lower in a parity two cow compared to an equivalent parity five plus cow (CI 0.59 – 0.71). Increasing milk yield at drying off was associated with an increased probability of new IMI and similar effects on the odds of new IMI were seen with the explanatory variable lactation length.

The predicted odds of new IMI was increased as the maximum SCC of the last five test days increased relative to the reference category of 21 – 30,000 cells/ml. An extremely low SCC of ≤ 20,000 cells/ml as the maximum of the last five test days had an increased probability of a new IMI relative to a SCC of 21 – 30,000 cells/ml; though this was not significant (OR = 1.44, 0.44 – 4.55).

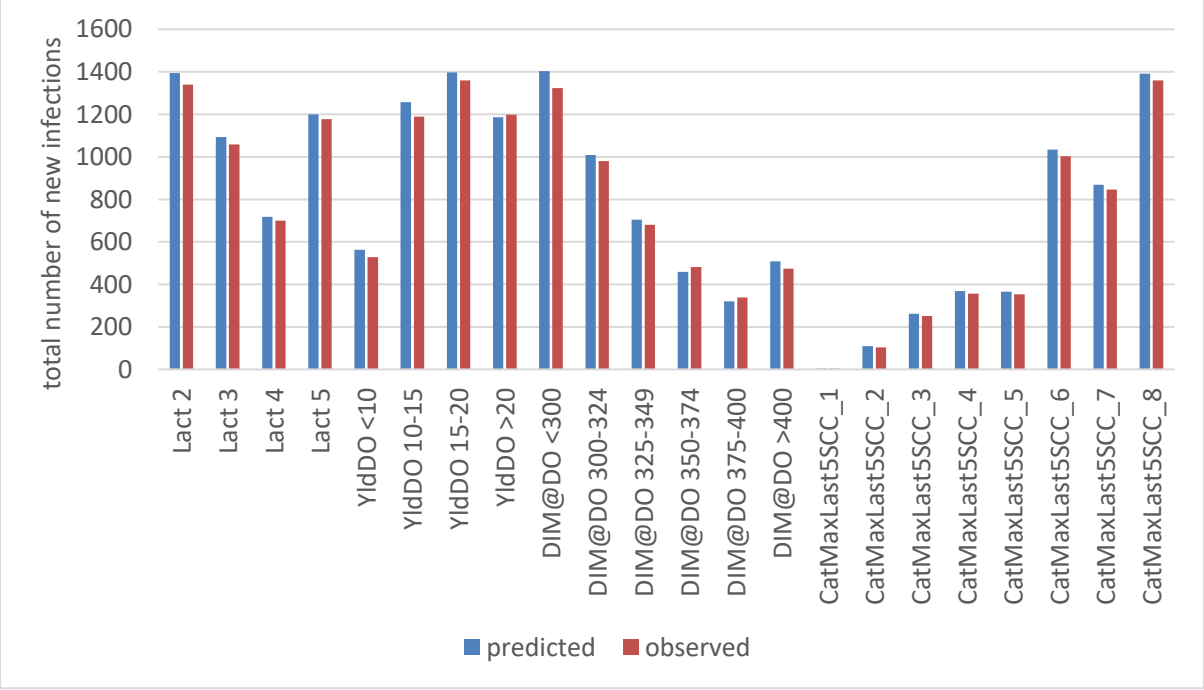


Figure 10 - Graph comparing predicted to observed values for New IMI.

Predictions for new IMI were compared to observed outcomes and chi-squared tests had a $p>0.05$ for each group of subsets tested, indicating good model fit (Figure 10).

Model Term	Coefficient	Odds Ratio	95 % Credible Interval
Intercept	-1.872		
Max SCC of last 5 test days (0 - 20,000 cells/ml)		1.41	0.44 – 4.55
Max SCC of last 5 test days (21 - 30,000 cells/ml)			REFERENCE
Max SCC of last 5 test days (31 - 50,000 cells/ml)		1.63	1.10 – 2.43
Max SCC of last 5 test days (51 - 70,000 cells/ml)		1.85	1.25 – 2.73
Max SCC of last 5 test days (71 - 90,000 cells/ml)		2.13	1.45 – 3.14
Max SCC of last 5 test days (91 - 150,000 cells/ml)		2.52	1.73 – 3.67
Max SCC of last 5 test days (151 - 199,000 cells/ml)		2.59	1.77 – 3.79
Max SCC of last 5 test days (> 199,000 cells/ml)		3.20	2.20 – 4.68
Proportion of lactation prior to current > 199,000 cells/ml (76 – 100%)			REFERENCE
Proportion of lactation prior to current > 199,000 cells/ml (51 – 75%)		0.65	0.42 – 1.01
Proportion of lactation prior to current > 199,000 cells/ml (26 – 50%)		0.55	0.38 – 0.79
Proportion of lactation prior to current > 199,000 cells/ml (3 – 25%)		0.51	0.36 – 0.70
Proportion of lactation prior to current > 199,000 cells/ml (0%)		0.36	0.26 – 0.50
Parity ≥5			REFERENCE
Parity 4		0.82	0.74 – 0.91
Parity 3		0.78	0.71 – 0.85
Parity 2		0.65	0.59 – 0.71
Milk Yield (kg) at last test day (per 10 Litres)		1.16	1.10 – 1.22
Lactation Length (per 100 days)		1.10	1.06 – 1.14
Herd Level Variance ($\sigma_u^{2)}$	0.202		

Table 14. Model 2: Results of the multilevel logistic regression model for the probability of new IMI in an individual cow across the dry period.

1 Maximum SCC last 5 test days = the categorized maximum SCC of the last 5 test days before drying off; Parity ≥5 = includes parity 5–16.

9 Discussion

The cure and new intra-mammary infection models produced predictions that discriminated well between cows in different risk categories. These findings demonstrate that lifetime cow records can be used successfully to predict whether individual cows are more or less likely to cure or develop a new intra-mammary infection during the dry period.

It has been established that both cow and herd factors during the dry period affect udder health in the early post-partum period (Green et al. 2007; Green et al. 2008). SCC at both the last test day prior to drying off and the first test day at the next lactation have been described to be useful on farm to assess the transition of IMI across the dry period (Madouasse et al. 2012).

9.1 Cure of intramammary infections

Mean cure across the dataset was very similar to a previous UK study using SCC data where mean cure was 72%, median 72.7% (IQR 63.6 – 81.5%) (Madouasse et al. 2010). This was higher than mean cure of 62.9% (median 62.4%) in a study of 145 Wisconsin herds (Cook et al. 2002). Cure was significantly associated with an increasing proportion of the current lactation and lactation prior to the current spent 'infected'. Increasing log SCC, age and number of quarters infected has been found to decrease predicted probability of cure (Sol et al. 1994); as has increased geometric mean natural log of the last three test days for composite SCC (Osterås et al. 1999). However, no previous studies have used earlier lactation records to create risk profiles for dry period outcome. A novel finding of this study is the effect of high SCC in earlier lactations and this suggests either that infections survive through sequential dry periods or that some cows are susceptible to repeated chronic

infections. However, this observation is based only on SCC as a proxy for infection and does not take into account the fact that these elevations of SCC across a time period may be the result of different bacterial pathogens rather than the same persistent infection.

Increased SCC at last test decreased the odds of cure and this concurs with a previous study reporting that individual SCC ≤ 60 days prior to drying off > 199,000 cells/ml was significantly associated with IMI within 30 days of calving (Green et al. 2008). Higher milk yield at last test was associated with a lower odds of cure though little evidence exists on the influence of yield at drying off on cure.

Increased lactation length resulted in a lower odds of cure though the mechanism behind this is unclear. However, a longer lactation may result in the acquisition of longer term chronic infections that become more difficult to cure (Green et al. 2007). Lower parity was associated with greater odds of cure, though research suggests this effect is inconsistent (Dingwell et al. 2003; Newman et al. 2010; Pinedo et al. 2012).

9.2 New intramammary infections

Mean new infection rates were comparable to previous UK work with a mean of 17.9%, median 16.7% (IQR 11.1 - 23.3%) (Madouasse et al. 2010), though lower than the mean of 22.4% (median 22.1%) in a study of 145 Wisconsin herds (Cook et al. 2002). Higher milk yield at last test was associated with higher odds of new infection and is in agreement with previous studies (Huxley et al. 2002; Rajala-Schultz et al. 2005; Newman, J. Rajala-Schultz, et al. 2009). Higher milk yield may increase intramammary pressure, milk leakage (Cousins et al. 1980; Schukken et al. 1993), dilute protective factors (immunoglobulins) and delay keratin plug formation making new infection more likely (Dingwell et al. 2004). Managing and reducing the likelihood of milk leakage post drying off is a very important part of

improving udder health during the dry period. However, very few farms appear to prioritise strategies at drying off to reduce the likelihood of this occurring and its impact on dry period origin (Bertulat et al. 2015; Down et al. 2016b). There is contradictory evidence regarding the effects of previous lactational yield. Of likely greater importance is the yield at drying off, which could be under the influence of the previous lactation yield, but also management practices associated with drying off. The potential for lactational yield to be a confounder in the effect of yield at drying off on IMI dynamics across the dry period has been suggested to warrant further examination (Huxley et al. 2002). Managing individuals or groups of cows to reduce milk yield before drying off is likely to be very important to reduce the risk of development of new IMI.

Increased odds of new infection was associated with increased days in milk at last test, which may lead to over conditioned (BCS ≥ 3.5) individuals at greater risk of immune suppression and new infection in the peri-parturient period (Suriyasathaporn et al. 2000). Or could be linked to higher genetic merit individuals having strong milking persistence and thereby lactation length. These cows may tend towards a higher risk of negative energy balance as a result of either over conditioning or possibly being thinner resulting in concurrent immunosuppression at next calving and an increased odds of new IMI.

Lower parity had a lower odds of new infection and this is in agreement with studies reporting increasing parity being associated with the occurrence of new infection in the dry period (Dingwell et al. 2004; Madouasse et al. 2012). With increasing parity, efficacy of anatomical or immune defences reduce and risk of new infections increases (Paganelli et al. 2006; Weng 2006; Green et al. 2007).

Probability of new infection significantly increased as the proportion of SCC > 199,000 cells/ml in the lactation prior to the current one increased. This appears surprising, however, one hypothesis for this may be that it is a marker of susceptibility to infection; cows with previous infections that apparently cure may be more susceptible to future new infections. Very low SCC (0 – 20,000 cells/ml) prior to drying off tended toward an increased odds of new infection. However, this association was not significant and should be interpreted with caution. Low SCC has been associated with increased risk and severity of clinical mastitis and we hypothesise that very low SCC (0 – 20,000 cells/ml) prior to drying off may be a risk factor for the development of new intramammary infection in the dry period (Suriyasathaporn et al. 2000; Peeler et al. 2003). An 'optimal' microbiome in the mammary gland is associated with a SCC in milk of between 21 – 30,000 cells/ml and has been proposed to provide a protective effect (Oikonomou et al. 2012; Oikonomou et al. 2014).

9.3 Applications and future development

9.3.1 Cows eligible for cure IMI

In cows unlikely to cure across the dry period, care could be exercised after calving, prior to the first recording of SCC, such that potentially infected cows may be segregated during milking or handled with care in the milking parlour, not given access to yards where cross suckling by calves could occur (Green et al. 2007) and considered for subsequent culling subject to infection status being confirmed in the next lactation (Sol et al. 1994; Dingwell et al. 2003).

All cows within this model were treated at drying off. An interesting concept in the future would be to create a model looking at prediction of cure comparing untreated animals and

treated animals across the dry period. The ability to select those individuals infected at drying off with a low probability of cure across the dry period that should not be treated with antibiotics and rather left untreated or at minimum dried off with a teat sealant would be of huge value. This would be significant as each use of antibiotics increases the selection pressure on resident microbial populations. Any possibility to reduce unnecessary use could be of significant value in making prudent decisions and aiding management of antimicrobial resistance within the veterinary industry (Osterås et al. 1999; Dingwell et al. 2003). In addition, other factors such as CM in the prior lactation and bacteriology prior to and at the point of drying off could be included in a future model to further improve the prediction of cure IMI at drying off (Osterås et al. 1999; Barkema et al. 2006).

9.3.2 Cows eligible for new IMI

In cows likely to develop new infections across the dry period, interventions should be targeted at environmental hygiene, milk yield at dry off or dry cow therapy (Green et al., 2007, 2008; Halasa et al., 2009a; b). The tendency for cows of low SCC prior to drying off being more likely to develop an IMI across the dry period is of interest and would warrant further investigation. If we could develop this relationship further it could put more emphasis on the possibility these individuals may need managing differently to other uninfected individuals prior to drying off. A policy sometimes recommended in some UK herds is the use of antibiotic dry cow therapy in these individuals. This is due to the inadvertent risk of infection introduction at drying off and the subsequent significant risk of severe illness in these individuals as a result of the low SCC and poor response in dealing with this challenge. However, the use of antibiotics in these individuals is currently not fully understood (Bradley et al. 2010).

9.3.3 Limitations

There were a number of limitations in this study, which in hindsight and with further development of the initial concept would be changed to enhance the outcomes of the study.

The generalisability of the dataset is limited as the data is taken from a milk recording organisation in the South West of England, which has a predominance of its clients in this area of the UK. The mean herd size for the initial raw dataset at 161 is also significantly larger than the UK average herd size of 102 for a comparable period in time from which the dataset was taken (AHDB 2019).

There are more robust approaches, which could have been used to assess model fit e.g. Hosmer–Lemeshow test. However, due to the time limited nature of this study, methods which were computational and labour intensive were not used when they have could have been.

Dry periods lengths greater than 100 days were included mistakenly included in the initial analysis and represents a flaw in the data reported within the study. However, the dataset has been reviewed and these dry periods removed and further analysis performed. This did not change what was already found to be significant in the model or the direction of associations with coefficient estimates remaining very similar.

The access data files provided by the milk recording organisation contained CM events, though these were not used to aid the development of the model. This represented a missed opportunity as further understanding of CM events prior to drying off could be useful to help support decisions around selective dry cow therapy as previously discussed.

Use of a single SCC prior to drying off and post calving to define infection could be argued to be flawed due to the potential for fluctuations in SCC. This does represent standard UK practice to define infection in this way across the dry period (Bradley & Green 2005), though it may have been more appropriate to look at the last 3 SCC prior to drying off and CM events in the 3 months prior to drying off as a definition for infection as this has been used in UK based research on the dry period (Bradley et al. 2010). In addition, the first three test days after calving could also have been considered to define infection status rather than solely the first test day.

Another specific limitation of the study design was that even though we set out to use lifetime records the transition of infection status across previous dry periods prior to those within the analysis was not considered as another variable within the models designed. This could be included in any future analysis. However, this would only be based on SCC as a proxy for infection with no bacteriology and we would need to be careful about inferences made regarding previous lactation status. Prior infection could linger from one dry period to the next, however without the use of bacteriology it would be difficult to determine this. It is very likely that previous bacterial infection will increase the risk of future infection and that specific quarters are susceptible to IMI (Dingwell et al. 2004; Green et al. 2002). It has also been proposed that previous infection has the potential to damage or change the environment within the udder, which subsequently compromises the innate immune defences (Green et al. 2002). There could also be specific characteristics related to individual quarters including suboptimal functioning of white cells and/or low white cell counts leading to increased susceptibility according to Green et al. (2002) referencing Hill (1981) and Peeler (2001).

On reflection it would have been logical split the data and create a training set and a testing set of data for development of the model and research outcomes.

9.4 Conclusions

This study has highlighted with respect to Cue IMI infection across the dry period that cows having a lesser proportion of test days with an elevated SCC in the lactation prior to drying off, a lesser proportion of test days with an elevated SCC in the lactation before the current lactation and of lower SCC prior to drying off were more likely to cure during the dry period. In addition, those individuals of lower parity, producing less milk and of lower days in milk at drying off were also more likely to cure.

Investigation of new IMI highlighted individual cows with a lesser proportion of test days with an elevated SCC in the lactation prior to the current one, of lower parity, lower milk production prior top drying off and lesser days in milk were of a reduced likelihood of developing new IMI across the dry period.

We must also consider that this approach will likely be more costly and has an increased risk of damage to the teat orifice and steak canal due to two infusions per teat being performed. However, the use of CDCT or a blanket approach to the use of antibiotics in uninfected cows is questionable in practice. The O'Neill Review in 2016 states that we must reduce the widespread and unjustifiable use of antibiotics in the livestock industry (O 'neill 2016).

The World Health Organisation (WHO) highlight a number of antibiotic classes used in DCT preparations as either critically important or highly important to human health (WHO 2017). The herd level use specific antimicrobials e.g. penicillins has recently been identified as

being associated with antimicrobial resistance against bovine mastitis pathogens, in particular Staphylococcus aureus in a farm setting (Saini et al. 2012).

Dry period length was found to have had no effect on the probability of cure IMI or development of new IMI across the dry period. The model predictions were able to demonstrate a high level of differentiation between cows of both a high and low likelihood of cure IMI and new IMI during the dry period. No other studies have previously investigated complete lifetime cow records available via milk recording organisations to predict the likelihood of dry period outcomes. This study clearly highlights this can be achieved and the initial objectives at the outset have been satisfied.

Farm decision support tools like this are likely to be extremely beneficial as an aid to management and this example has been commercialised for use by veterinary practitioners in the UK through TotalVet (QMMS & SUM-IT Software) software. Knowledge of a risk profile for cure or new infections across the dry period for individual cows can be of practical use on farm.

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11 Clinical Portfolio

Senior Clinical Training Scholarship 2013 - 2016

Andrew Henderson

BVSc Cert AVP (Cattle) Dip ECBHM MRCVS

11.1 Introduction

This section describes my clinical and professional development and achievements during my clinical training scholar program.

The research portion is described in the accompanying dissertation, which is taken from work previously described in the Journal of Dairy Science (Henderson, A. H., Hudson, C. D., Bradley, A. J., Sherwin, V. E. and Green, M. J. (2016). Prediction of intramammary infection status across the dry period from lifetime cow records. Journal of Dairy Science, 99 (7). pp. 5586 – 5595.

During the clinical training scholarship my time has been split 50:50 between clinical work and teaching at Scarsdale Veterinary Group (an associate practice to the University of Nottingham School of Veterinary Medicine and Science [SVMS]), research, consultancy and practical teaching at SVMS.

The primary goal for this program, in addition to the MVM was to complete the credentials for and sit the qualifying examinations for the European Diploma of Bovine Health Management.

11.2 European Diploma of Bovine Health Management

This is a European Qualifications Framework level 8 qualification, therefore being the equivalent of a PhD. In order to meet the credentials to allow a candidate to sit the examination one must:

1. Complete at least 2.5 years of an approved training program at a recognised training centre.
2. Produce five case reports, which meet a standard set by the European College of Bovine Health Management.
3. Complete a detailed set of case logs of clinical cases, herd health cases, seminars, lectures and attendance at CPD.
4. Conduct at least 30 necropsies.
5. Attend at least 3 national or international conferences on bovine health.
6. Publish two peer review papers in relevant journals; one a piece of original research as named first author and first author on a review paper on area of speciality or named author on a peer review research paper.
7. Present at one national or international conference in the area of bovine health management.

The case reports, summary of case logs and individual case logs for the three years of training can be seen in the subsequent appendices.

In October 2015 & 2016 I presented the findings of my research at the British Cattle Veterinary Association annual congress.

I successfully sat passed the examination for the European Diploma of Bovine Health Management in July 2016.

11.3 Other awards

During my training program I also sat and passed the final examination (viva voce) of a Certificate in Advanced Veterinary Practice with a designation in Cattle in June 2014. This is a modular qualification and represents a European Qualifications Framework Level 7 qualification. I began this qualification in June 2010 completing all of the modular coursework through the University of Edinburgh and the final viva voce at the University of Liverpool.

Following the award of this qualification I was eligible to become an RCVS Recognised Advanced Practitioner in Cattle and Health Production in 2015.

Following passing the European Diploma of Bovine Health Management in July 2016, I became a European Specialist in Bovine Health Management and as a result of this in 2017 became an RCVS Recognised Specialist in Cattle Health and Production.

11.4 Other publications

Hyde, R; Henderson, A and Hudson, C (2016) *Recognition and management of pain in cattle***.** **Livestock**: 21 (6) pp. 1 – 6.

Henderson, A; Hudson, C; Bradley, A; Shewin, V and Green M (2016) *Prediction of intra-mammary infection status across the dry period from lifetime cow records.* **Journal of Dairy Science:** 99 (7): pp. 5586 – 5595.

Sherwin, V; Hudson, C; Henderson, A and Green M (2016) *The association between age at first calving and survival of first lactation heifers within dairy herds.* **Animal**: 10 (11): pp. 1877 – 1882.

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11.5 Appendix 1 - Bull Breeding Soundness Examination

Andrew Henderson

ECBHM Case Report 1

11.5.1 Complaint

A farmer requested that a vet attend to examine a 24 month old pedigree Charolais bull bought four months previously. The client was concerned there was a possible failure of intromission specifically due to corkscrew penis and therefore a failure to get cows pregnant.

11.5.1.1 Background Information

11.5.1.2 Farm Profile

The farm was 100 hectares of mostly lowland with good quality grazing and 12 hectares set aside for arable crops such as oats, spring barley and wheat. They also maintained a 200 mule sheep flock lambing in February and March.

11.5.1.3 Herd Size and Breed

The herd comprised 90 suckler cows and 2 stock bulls. The herd were a mix of Charolais and Limousin crosses. The two existing stock bulls were pedigree Charolais.

11.5.1.4 Calving Pattern & breeding management

There were two calving blocks; one in the spring and one in the autumn. Spring calving began at the start of April and lasted until the end of May. Autumn calving began in mid-September and did not have a set finishing point. Bulls were rotated every 3 weeks with the spring calving group. In the autumn calving group bulls were rotated day and night.

11.5.1.5 Herd Replacements

Replacement heifers were homebred with none having been bought in the previous five years. The stock bulls were bought from local pedigree sales as virgin bulls and both were now aged 6 years. Heifers were managed to calve before or at the beginning of the calving season over a six week period.

11.5.1.6 Calf Management

Spring born calves were weaned in November prior to housing and sold in March. Autumn born calves were weaned prior to housing and sold the subsequent autumn before housing for a second winter. All calves were castrated using an elastrator ring within the first week

of life and disbudding was carried out from 4 weeks of age by the farmer. Creep feed was provided for all calves from 3 – 4 months of age with home grown ground wheat being used.

11.5.2 Case Background

11.5.2.1 History

The bull had been purchased to replace the older of the two existing stock bulls. He had initially shown a lack of libido after purchase, though this was temporary and he was then mated individually with 6 cows in a bull pen over a period of two weeks. These 6 cows all returned to oestrus after 3 weeks indicating they had not conceived. The bull was then introduced to a group of 20 cows with the same outcome. It was at this point the farmer felt the bull showed signs of corkscrew penis and requested a vet to attend. No females were available for pregnancy diagnosis to confirm the above observations because an existing stock bull had been introduced to the group once the new bull had shown signs of sub-fertility.

11.5.2.2 Service Capacity and Libido Assessment

Prior to veterinary attendance on farm an oestrus female was requested to be present so that a serving assessment could be performed. The bull was placed in a small straw yard with an unrestrained female and observed for a period of 20 minutes. During this time the bull showed interest, mounted and achieved a successful service twice. No abnormalities of the penis or the musculoskeletal system were observed. Serving assessments are qualitative determining whether a bull can actually serve and quantitative in providing evidence of libido (AACV, 2002).

11.5.2.3 Infectious Disease

The bull was screened for bovine viral diarrhoea virus (BVDV) (antibody and antigen), infectious bovine rhinotracheitis (IBR) and leptospirosis antibody via blood sampling prior to sale; and all tests were found to be negative. Preputial washing was not carried out for evidence of *Campylobacter fetus venerealis* or *Trichomonas foetus* because he was a virgin bull. Therefore, risk was considered low enough to make testing unnecessary.

11.5.2.4 Initial Assessment

On the basis of the serving assessment and history, a tentative diagnosis of sub-fertility was made. The owner was advised to have a bull breeding soundness examination (BBSE) performed.

11.5.2.5 Clinical Examination

A BBSE was performed the next day. This followed the protocol on the British Cattle Veterinary Associations (BCVA) bull pre-breeding examination certificate. Electro-ejaculation (EEJ) was used to obtain a semen sample for evaluation. A detailed description of the equipment and technique used is provided in Appendix 1 and 2.

In brief the bull was loaded into the crush and a physical assessment was performed including body condition score (BCS), heart/lung auscultation, eye examination, incisor and dental pad alignment, musculoskeletal system, external genitalia, internal accessory glands and scrotal circumference measurement. Following this a semen examination was performed using electro-ejaculation (EEJ) to allow assessment of gross motility, progressive motility and morphology.

11.5.3 Results

11.5.3.1 General clinical examination

The BCS of the bull was 3 (Scale 1 – 5) and considered normal. Nothing abnormal was detected on heart and lung auscultation.

Both eyes were free from evidence of infectious bovine kerato-conjunctivitis (IBK) and squamous cell carcinoma (SCC). The incisors were correctly aligned with the dental pad; showing no evidence of an undershot or overshot jaw.

The bull was led around the yard on a halter and the musculoskeletal system was normal with no signs of an abnormal gait.

The testicles were even, but had poor tone and resilience. The scrotal skin was pliable with no thickening. The penis was observed twice during the serving assessment and erection was achieved during EEJ. Scrotal circumference (SC) was measured and found to be 34cm.

Rectal palpation of accessory sex glands (ampulla, prostate, seminal vesicles and bulbourethral) proved normal.

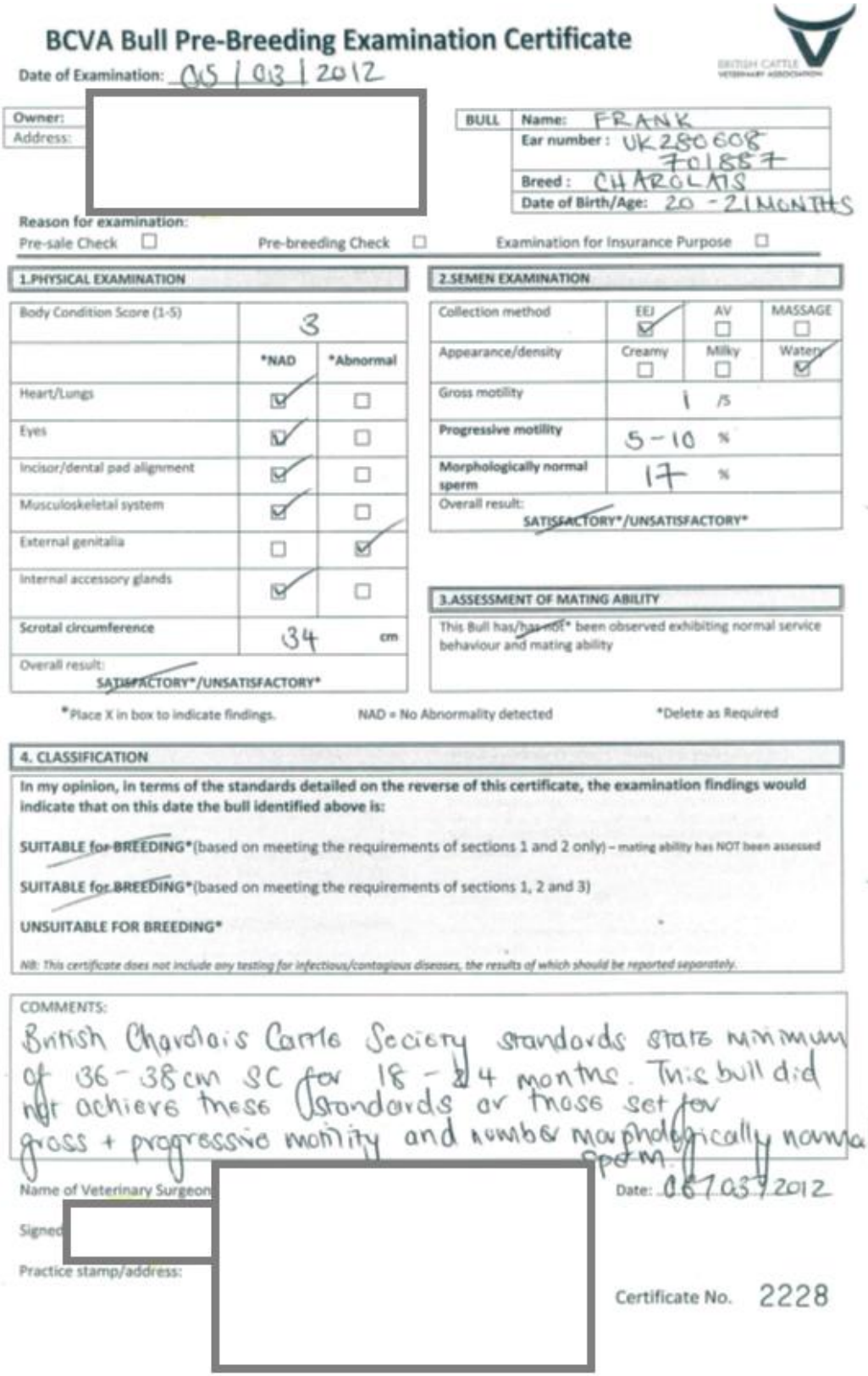
11.5.3.2 Gross motility & progressive motility

Three attempts were made to achieve a representative sample, with the final sample being described. Multiple samples were taken to account for 'rusty load'. This occurs in bulls which have not worked before or for a long period allowing accumulated sperm to age and degrade. This will present with poor motility on the first sample. Gross motility scored 1 (Scale 1 – 5) and progressive motility was assessed as 5 – 10%.

11.5.3.3 Morphology

Two smears were made using nigrosin-eosin and sperm morphology was assessed. The results of the morphological assessment can be seen in Table 1. This bull was found to have only 17% morphologically normal sperm. Of these morphologically abnormal sperm, 69% and 16% showed proximal cytoplasmic droplets and pyriform heads respectively.

Results of the complete BBSE are provided in Figure 1.



BCVA Bull Pre-Breeding Examination Certificate

Date of Examination: 05 / 03 / 2012

Owner:
Address:

BULL
Name: FRANK
Ear number: UK 280608 701857
Breed: CHAROLAIS
Date of Birth/Age: 20 - 21 MONTHS

Reason for examination:
Pre-sale Check ☐ Pre-breeding Check ☐ Examination for Insurance Purpose ☐

1.PHYSICAL EXAMINATION

Body Condition Score (1-5)	3	
	*NAD	*Abnormal
Heart/Lungs	☑	☐
Eyes	☑	☐
Incisor/dental pad alignment	☑	☐
Musculoskeletal system	☑	☐
External genitalia	☐	☑
Internal accessory glands	☑	☐
Scrotal circumference	34 cm	
Overall result: SATISFACTORY*/UNSATISFACTORY*		

2.SEMEN EXAMINATION

Collection method	EEJ ☑	AV ☐	MASSAGE ☐
Appearance/density	Creamy ☐	Milky ☐	Watery ☑
Gross motility	1 /5		
Progressive motility	5-10 %		
Morphologically normal sperm	17 %		
Overall result: SATISFACTORY*/UNSATISFACTORY*			

3.ASSESSMENT OF MATING ABILITY

This Bull has/has not* been observed exhibiting normal service behaviour and mating ability

*Place X in box to indicate findings. NAD = No Abnormality detected *Delete as Required

4. CLASSIFICATION

In my opinion, in terms of the standards detailed on the reverse of this certificate, the examination findings would indicate that on this date the bull identified above is:

SUITABLE for BREEDING* (based on meeting the requirements of sections 1 and 2 only) – mating ability has NOT been assessed

SUITABLE for BREEDING* (based on meeting the requirements of sections 1, 2 and 3)

UNSUITABLE FOR BREEDING*

NB: This certificate does not include any testing for infectious/contagious diseases, the results of which should be reported separately.

COMMENTS:
British Charolais Cattle Society standards state minimum of 36 - 38 cm SC for 18 - 24 months. This bull did not achieve these standards or those set for gross + progressive motility and number morphologically normal sperm.

Name of Veterinary Surgeon
Signed
Practice stamp/address:

Date: 05/03/2012

Certificate No. 2228

Figure 6 - BCVA BBSE Certificate: The aim of this certificate is not to guarantee fertility but to reduce the risk of unsuitable bulls being used for breeding purposes. Bulls meeting the requirements in section 1 & 2 should have no physical abnormality rendering them unable to carry out natural service & have the potential to be fully fertile based on semen quality (BCVA, 2010).

Morphological Abnormality	Proportion (%)	Acceptable Level (%)
Tail abnormalities and Loose heads	0	≤30%
Proximal cytoplasmic droplets	69	≤20%
Mid-piece abnormalities	0	≤30%
Pyriform heads	16	≤20%
Knobbed acrosomes	0	≤30%
Vacuoles & Teratoids	0	≤20%
Swollen acrosomes	0	≤30%
Morphologically Normal	15	≥70%
Total	100	

Table 13 – The percentage of morphological abnormalities detected in the semen of bull tested in this case (AACV, 2002).

11.5.3.4 Diagnosis

11.5.3.5 Differential Diagnosis

1. Testicular degeneration or hypoplasia.
2. Epididymal degeneration, occlusion, hypoplasia, aplasia.
3. Orchitis.
4. Epididymitis.
5. Seminal Vesiculitis

11.5.3.6 Primary diagnosis

- Testicular and/or epipdidymal degeneration/hypoplasia.

This was chosen as the definitive diagnosis for a number of reasons.

The serving capacity assessment had indicated that the minimum Australian Association of Cattle Veterinarians (AACV) requirements of at least one serve within 10 minutes was achieved. A normal penis and musculoskeletal function was identified. Libido was not an evident problem as the bull showed interest in the oestrus female.

Recommended mating loads for a bull of this age when mated in hand is 7 females per week. This bull had been initially mated with 6 females over a period of two weeks. Therefore, this could not be considered an excessive workload and a reason for the breakdown in fertility (Logue and Greig, 1986).

There was no evidence of penile abnormalities during the serving assessment.

The bull was 21 months of age with a 34cm scrotal circumference (SC) and would pass BCVA guidelines adopted from SFT (Society for Theriogenology). However, breeds in the UK generally easily pass these minimum standards and where breed society standards are present these should be used. The Charolais Cattle Society state that bulls of 18 – 24 months of age should attain SC of 36 – 38cm, meaning this bull had under developed testicles with poor tone and resilience and was therefore unsatisfactory for breeding.

Differentials 3, 4 and 5 were ruled out due to the lack of pain, heat, swelling or abnormality found on clinical examination of these areas. Furthermore, no evidence of pus or blood was found in the gross semen sample and on microscopic examination there was no evidence of

inflammatory cells. Bulls afflicted by seminal vesiculitis also resent rectal palpation and EEJ, which was not the case.

Therefore the history and clinical/laboratory evaluation suggested the bull was suffering from testicular and/or epididymal hypoplasia/degeneration.

11.5.3.7 Sequelae

As a result of the BBSE and history the bull was classified as unsuitable for breeding. The Charolais Cattle Society and auctioneer were informed and provided with the results of the veterinary examination. The vendor agreed the bull should be slaughtered with the buyer receiving the slaughter price and the vendor paying for the cost of the BBSE and compensating the difference of slaughter price from the original purchase price.

11.5.3.8 Economics

11.5.3.9 General

A useful measurement of efficiency and output in beefs herds is the weight of calf weaned per female bred per year (Lowman 1988) (Statham et al. 2007) (Caldow et al. 2007) (Caldow et al. 2005) (McGowan, 2004). This is determined by reproductive efficiency, calf mortality, growth rates and quality of the end product (Statham et al. 2007). In this case the main effect on farm profitability will be the failure to achieve a breeding season of less than 10 weeks with greater than 65% of the cows calving within the first 3 weeks (Penny, 2009).

Extension of the 365 day target for calving interval (CI) has been estimated to cost £1/cow per day (Statham et al. 2007). This is an outdated estimate of the present day cost since Statham et al. (2007) had calculated this from a Livestock Meat Commission (LMC) costing in 2005. In the proceeding ten years fixed costs such as land rent and finance costs and variable costs such as fertiliser, concentrate and forages have increased dramatically. Hence, the cost per day of an increase in CI will be greater than £1/cow per day.

The cost of extending the calving interval is due to a range factors. These include rearing fewer calves, weaning a lower calf weight per cow per year, uneven weaned groups increasing management costs because tasks such as castration cannot be performed at the

same time, increasing number of cows are found to be barren at the end of the season and increased feed costs (Statham et al. 2007).

11.5.3.10 Herd Specific

A 90 cow suckler herd such as this, with an estimated increase in CI by 21 days due to failure of the bull would be expected to lose £1890 over that breeding season if we assume costs remain at 2005 levels; or £6577 if we use the information provided in Table 2.

Cost per year of keeping one suckler cow (feeding, overheads & depreciation)	**£584**
Cost per day of keeping one suckler cow (cost per year/365 days)	£1.60
Price per kilogram of liveweight (Steer or Heifer – UK market average September 2014)	£1.88
Target Youngstock Growth Rate	1kg/day
Cost of each day of extension to calving interval	£1.60
Cost of each day of shortening of rearing period	£1.88
Estimated combined cost of each extra day on calving interval per cow and each day of shortening rearing period	£3.48

Table 14 - Cost of additional day added to a 365 day calving interval. Each additional day will add feed costs, land/housing costs and depreciation to keeping each cow but will also shorten the calf rearing period by a day resulting in lower slaughter weights (EBLEX, 2014) (Teagasc, 2014).

11.5.4 Discussion

11.5.4.1 BBSE Background

BBSE is a routine procedure in the USA, Canada and Australia. However, this is not routinely practiced in the UK, with a standard bull breeding certification system only being introduced in 2010 (Penny, 2010). Bulls reaching the minimum requirements for a BBSE have been found to achieve a 9% higher group pregnancy rate (Penny, 2009). This shows the value of BBSEs and is supported by a number of studies. A study of bulls on 72 farms in Scotland showed an average fail rate of 33.4% increasing to 52% in bulls over 6 years of age (Eppink et al. 2005). Only 60% of these failures could be identified by physical examination alone (Eppink et al. 2005) (Penny, 2009) (Penny et al. 2010).

11.5.4.2 Serving Capacity and Libido Assessment

BBSEs are not a guarantee of fertility but of the probability of fertility. It has also been found that 4.8% of bulls passing a BBSE failed to serve cows, so it should be remembered BBSEs give no indication of libido and bulls should be closely observed (Penny et al. 2010) (Eppink et al. 2005) (AACV, 2002).

Corkscrew penis or premature spiral deviation of the penis (PDSP) is caused by insufficiency in the dorsal apical ligament of the penis. In some bulls, PDSP is only evident after 4 serves have been performed in quick succession. Four serves were not observed in this instance but in general it is preferable that 4 serves are observed during a serving capacity assessment However, PDSP is most common in polled beef breeds and uncommon in virgin bulls (AACV, 2002) and therefore was unlikely in this case.

11.5.4.3 Bull Breeding Soundness Examination

11.5.4.3.1 Body Condition Score

A smaller proportion of bulls with a BCS of 2 and ≥4 have semen of satisfactory quality relative to those of BCS 2.5 – 3.5 (Barth & Waldner, 2002). This would suggest that at the time of examination, in this case body condition was not influencing reproductive parameters. Fat deposition around the testicles in bulls of BCS ≥4 affects thermoregulation influencing sperm motility and morphology. Bulls of poorer BCS or those losing excessive condition will show testicular degeneration resulting in poor reproductive parameters. This bull may have been obese on farm entry, 5 months prior to BBSE. However, as

spermatogenesis takes 61 days and passage through the epididymis 10 – 12 days it seems unlikely that condition loss post sale would still be influencing sperm quality (Barth & Waldner, 2002) (AACV, 2002).

11.5.4.3.2 Musculoskeletal system

Examination of the musculoskeletal system has shown that 5% of bulls have leg and feet problems (AACV, 2002). Physical abnormalities of feet/legs do not affect semen quality. However, these will affect the bull's long term performance, with 31% of UK bulls being culled for musculoskeletal issues (Penny et al. 2001). Physical abnormalities will also have a major impact on serving capacity.

11.5.4.3.3 Ocular examination

Examination of the eyes was carried out to identify scarring from IBK or early signs of squamous cell carcinoma (SCC). Musculoskeletal and ocular examination is important as bulls must be able to seek out females in oestrus, mount and serve without delay (AACV, 2002) (Barth & Waldner 2002)(Penny et al. 2001) .

11.5.4.3.4 Internal accessory glands

Rectal palpation of accessory sex glands is important especially in young bulls. Young bulls are most commonly diagnosed with seminal vesiculitis. This presents with swelling, loss of lobulation, pain on palpation or electroejaculation being found. Blood and pus may also be found in the semen. This condition may be associated with high energy diets fed to young bulls (AACV, 2002) (McGowan, unknown).

11.5.4.3.5 External Genitalia

The scrotum, testicles and epididymis are carefully examined to ensure absence of orchitis, epididymitis, hernias or vesicles. This is done by assessing tone and resilience of the testicle and palpation of the neck of the scrotum. Slight variation in size, shape and position is considered normal and allowed. Scrotal skin should be pliable with no thickening.

In this case the penis was observed twice during the serving assessment and erection was achieved during EEJ. This indicated absence of common conditions of the penis such as

penile deviation, trauma, fibro-papillomata and balanoposthitis (AACV, 2002) (Penny et al. 2010).

11.5.4.3.6 Scrotal circumference

SC is a good indicator of sperm production capacity. It is highly heritable and hence influences male offspring SC and is also genetically associated with fertility of female offspring (AACV, 2002; Penny, 2010). Bulls below minimum SC should be considered as having testicular hypoplasia and being subfertile (Penny, 2010). SC is also strongly correlated with sperm motility and morphology (AACV, 2002) (Barth & Waldner 2002) (BCVA, 2010) (Penny et al. 2010).

11.5.4.3.7 Density & appearance

Density of the semen sample is of little value as concentration can vary as a result of collection method and is poorly related to fertility (AACV, 2002) (Penny et al. 2005).

11.5.4.3.8 Gross motility

Gross motility is determined by concentration, % progressively motile and speed of progression and a score of ≥3 (slow distinct swirl) should be achieved. This should be used as guide as it is poorly correlated with fertility although it is suggested that bulls scoring ≥3 tend to have good progressive motility if semen is handled appropriately (AACV, 2002) (Penny et al. 2010).

11.5.4.3.9 Progressive motility

Progressive motility is assessed by diluting the semen sample. The accepted minimum standard is 30% and this is supported by AACV (2002) where the acceptable minimum standard for natural mating is ≥ 30% (Penny et al. 2005). Logue and Grieg (1987) state that ≥ 50% is desirable. However the BCVA Pre-Breeding Examination requires ≥ 60% and AACV primary threshold is also ≥60% as some bulls may provide semen for freezing. Sperm motility is well correlated with bull fertility therefore this is an important measurement. Barth and Waldner (2002) suggest there is a high correlation between gross motility and morphology. However, good gross motility may be achieved even with a large number of dead sperm (AACV, 2002).

11.5.4.3.10 Morphology

The internationally accepted standard for sperm morphology to achieve good fertility is ≥ 70%. This measure is strongly correlated with fertility (Barth & Waldner, 2002). High levels of morphological abnormalities clearly indicate degenerative changes or hypoplasia of the testicles and/or epididymis.

Proximal cytoplasmic droplets in a mature bull indicate abnormal spermiogenesis and/or epididymal dysfunction. They may be seen associated with head defects, as in this case and if bulls recover they may do so in 6 weeks. Prognosis depends on the type of other abnormalities found and in this case it seems unlikely to recover as this trait is uncompensable and when this defect is >30%, apparently normal sperm also have reduced fertilisation ability. Furthermore, pyriform heads are also an uncompensable trait, though they can be normal in some bulls in the absence of other defects. It is commonly seen in over conditioned young bulls but this bull was BCS 3. In summary the poor reproductive performance, sub optimal SC and failure to produce a semen sample meeting gross/progressive motility, sperm morphology targets and the desire of the client would support the culling of this animal (AACV, 2002).

11.5.5 Summary

This case study demonstrates the value of a BBSE examination and how useful it can be to determine the reason for sub fertility in these circumstances. In this instance the realisation of the problem was too late to prevent significant loss; highlighting the importance of pre-breeding or post purchase BBSE for all stock bulls.

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11.5.6.1 Appendices

11.5.6.2 Appendix 1 – Equipment used

1. Microscope.
2. Heated stage.
3. Microscope slides & cover slips (pre-warmed on heated stage).
4. Slide holding box.
5. Freshly prepared nigrosin – eosin stain.
6. Test tube pre-filled with freshly prepared sterilised phosphate buffered saline.
7. Disposable pipettes.
8. Disposable director cone.
9. BCVA bull pre-breeding examination certificate.
10. A water bath at 37°C for pre-warming stain, PBS & holding sperm sample at correct temperature for examination.
11. Lane Pulsator IV.
12. 60mm weighted bull probe.
13. Scrotal tape.
14. Semen collection handle.

(Penny, 2005)

The equipment was set up in the kitchen where it was warm but also a short distance from the crush. All the equipment was pre-warmed to ensure that motility assessment was correct and not influenced by cooling as a result of poor semen handling (Penny, 2005).

11.5.6.3 Appendix 2 – Technique

1. The bull was restrained in a crush with doors opening on the sides providing access to the prepuce.
2. A rump rail in the crush was placed behind the bull to prevent kicking out backwards when examination was performed from behind.
3. A clinical examination was performed following the BCVA certificate.

4. Preputial hairs were clipped to prevent contamination of the semen sample.
5. Rectal massage of the ampullae, prostate and pelvic urethra was performed to pre-stimulate the bull prior to insertion of the probe.
6. The seminal vesicles were not massaged as this can result in discharge of a large amount of seminal fluid into the urethra prior to ejaculation, which could dilute the evaluated sample (AACV, 2002)
7. The probe was lubricated prior to insertion into the rectum with the electrodes ventrally placed to ensure stimulation of bull.
8. The tail was placed between the U shaped handle and held in place by an assistant during stimulation.
9. The Lane Pulsator IV was set to a programmed mode and semen subsequently collected after erection had been achieved and pre-ejaculate passed. Semen was then evaluated for gross motility at ×40 magnification and progressive motility at ×400.
10. The bull was ejaculated 5 minutes later as it failed to meet accepted standards for gross and progressive motility. This was to rule out sperm accumulation and senescence as a cause (BCVA, 2010).
11. The seminal vesicles were then palpated. They are lobulated extending forward bilaterally from the prostate at an angle. In a bull of this age measuring roughly 6 – 8cm (AACV, 2002).

11.6 Appendix 2 – Mastitis Investigation

ANDREW HENDERSON

ECBHM CASE REPORT 2

11.6.1 Case summary

A client had an elevated 3 month rolling somatic cell count (SCC) and incidence rate of clinical mastitis (IRCM). It was decided with the client that the AHDB Dairy Mastitis Control Plan (DMCP) should be implemented.

11.6.2 Background Information

11.6.2.1 Herd size, breed, fertility management & production

The herd comprised 191 Holstein Friesians calving all year round. The herd was split into early and late lactation groups. The early lactation group were bred using artificial insemination and the late lactation group bred with a Hereford sweeper bull. Heifer replacements were reared off farm on contract from weaning at 10 weeks of age and then returned 3 weeks pre-calving. Replacements receive 2 services with sexed semen and are then bred to a Hereford bull. Total annual milk sales were 1.6 million litres, equating to a 305 day milk yield of 8,024 litres with a 12 month rolling mean of 3.38% protein and 3.87% butterfat.

11.6.2.2 Housing

Lactating cows were housed on deep bedded straw cubicles on concrete bases; the early lactation group also had rubber mats on top of the concrete bases. All lactating cows were grazed from March to October. Dry cows were managed in two groups; a far off group and a close up group for three weeks. The target dry period length is 60 days. All cows were housed from October to March; but from March to October the late lactation group and far off dry cows were grazed. Freshly calved cows are housed on a loose straw yard for 1 – 2 weeks post calving and are mixed with cows suffering from lameness, unspecified illness and clinical mastitis (CM).

11.6.2.3 Udder health

Assisted milk recording was carried out with National Milk Records (NMR) on a monthly basis to provide milk yield and SCC information. All clinical mastitis records are recorded on paper on farm.

11.6.2.4 AHDB Dairy Mastitis Control Plan (DMCP)

The DMCP is a national mastitis control initiative in the UK based on the results of a randomised clinical trial (RCT) carried out in England and Wales in 2004. The RCT demonstrated a 22% reduction in the proportion of cows affected with clinical mastitis, the IRCM and the rate of new infections as measured by SCC. By 2012 over 250 private veterinary surgeons were trained to deliver the Plan and it had been implemented on over 950 farms, which is in excess of 10% of the national herd (Bradley et al. 2007; Dairy Co. 2012). The DMCP attempts to establish a complete overview of the situation on farm and a full investigation consists of:

1. Collecting mastitis data (SCC and clinical mastitis (CM) cases).
2. Categorising farm based on epidemiological patterns.
3. Conducting a farm visit to assess management.
4. Identifying potential control measures relevant to the farm diagnosis.
5. Prioritisation and communication of control measures.
6. Continual monitoring.

11.6.3 Farm Data Analysis

A NMR common layer data file (CDL) containing SCC and CM data was uploaded onto TotalVet (TV) software. TV was then used to carry out detailed analysis and categorisation of farm mastitis patterns.

11.6.3.1 Somatic cell count & Clinical mastitis summary

	JUNE 2010	ROLLING 3 MONTH	ROLLING ANNUAL	TARGET
LACTATION NEW INFECTION RATE (SCC)	4.0	8.6	7.1	< 5%
DRY PERIOD NEW INFECTION RATE (SCC)	16.7	45.5	24.4	< 10%
DRY PERIOD CURE RATE (SCC)	20.0	53.3	60.3	> 85%
FRESHLY CALVED INFECTION RATE (SCC)	35.3	45.8	30.2	< 10%
% HERD CHRONICALLY INFECTED (SCC)	14.0	11.1	10.9	< 10%
% HERD WITH SCC > 200,000 CELLS/ML	20.8	22.0	18.4	< 20%
BULK MILK SCC (1000 CELLS/ML)	210	247	183	< 200
NUMBER OF CM CASES/100 COWS/YEAR	180	111	88	≤ 30
RATE OF NEW CM OF APPARENT DRY PERIOD ORIGIN (COWS/12)	6.73	3.82	2.99	1
RATE OF NEW CM OF APPARENT LACTATION ORIGIN (COWS/12)	2.63	2.87	2.51	2

Table 1 - Somatic cell count and clinical mastitis summary: *The above table illustrates mastitis indices for the somatic cell count and clinical mastitis analysis carried out using TotalVet. The indices described are highlighted for July 2010 at the time the investigation was performed, the rolling 3 month average leading up to July 2010 and the rolling 12 month average finishing July 2010.Targets are also provided indicating the suggested level of performance which is possible (See Appendix 4 for definitions of indices).*

11.6.3.1.1 Comment

The percentage of the herd with a SCC ≥ 200,000 cells/ml is within target for the 12 month rolling annual, though the 3 month rolling figure has increased above a target of less than 20%, to 22%. The proportion of the herd chronically infected (12 month average) is 10.9% and therefore on target, though is elevated for July 2010 to 14%. On further examination of SCC, lactation new infection rate (12 month average) appears well controlled being only slightly above target and below target for July 2010 at 4%.

The freshly calved infection rate (3 month average) is 45.8% and well above a target of < 10%. We must break this down to look at new infection rate and dry period cure rate. The dry period new infection (3 month average) and the dry period cure rate (3 month average) are 45.5% and 53.3%; well above and below a target of < 10% and > 85% respectively. This would suggest the poor SCC performance of this herd highlighted by the elevated proportion of the herd chronically infected, proportion of the herd ≥ 200,000 cells/ ml and bulk milk SCC (3 month average) of 247 is being driven by the dry period, particularly in the last 3 months.

IRCM is well above a suggested target of ≤ 30 cases/ 100 cows/ year at 87 cases/ 100 cows/ year. However, the last 3 months is especially poor with the rate rising to 111 cases/ 100

cows/ year and the rate within June 2010 even higher at 180 cases/ 100 cows/ year. Investigation of the source of index or first cases highlights that the rate of new CM cases of apparent lactation origin is just above target in the last 12 months. The rate of new clinical cases of apparent dry period origin is 3 times, nearly 4 times and over 6 times target in the last 12 months, last 3 months and June 2010 respectively. This would suggest that the extremely high IRCM is occurring as a result of cases occurring within the first 30 days of lactation and therefore most likely from infections arising during the dry period.

11.6.3.2 Fresh calver infection rate (SCC)

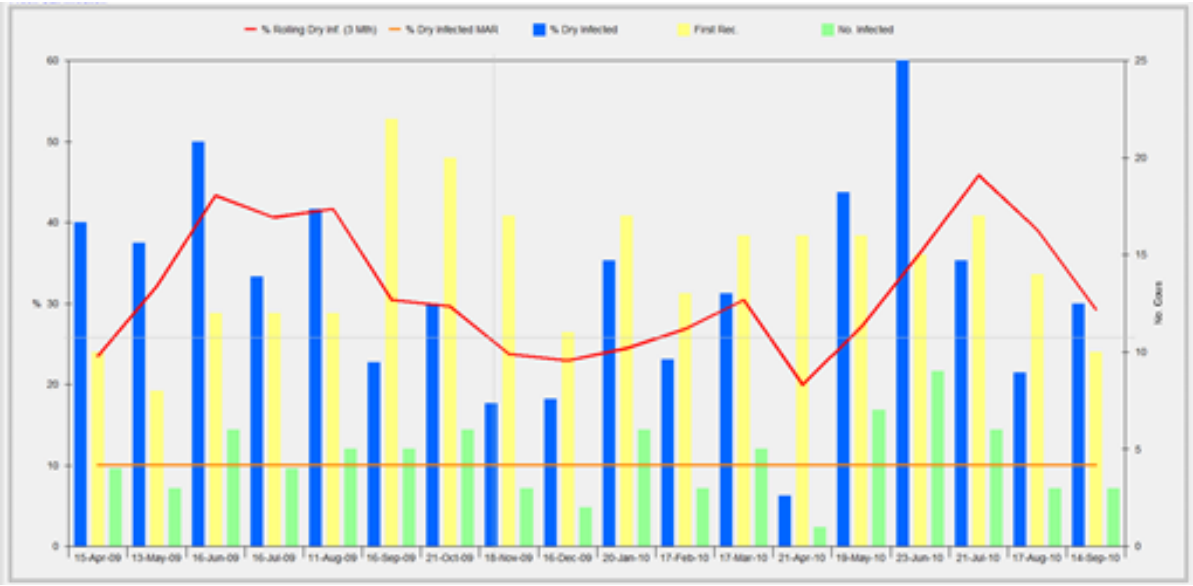


Figure 1 - Fresh Calver Infection Rate (proportion of all cows and maiden heifers that calve into the herd and are > 200,000 cells/ml at the first test-day in lactation): *the yellow bars show the number of animals calved and having a first recording in that month; the green bars the number that were > 200,000 cells/ml (likely to be infected) at the first test-day; the blue bars are the infection percentages for each test-day; the red line is the rolling 3-month average. The orange line is a target of 10% of fresh calved animals > 200,000 cells/ml < 30 days after calving.*

11.6.3.2.1 Comment

The freshly calved infection rate was 35.3% in June 2010, though reached a peak of 46% in July 2010 before declining to September 2010. This peak is also evident in June 2009, were it peaked at 43%. This clearly shows strong seasonal variation with a significantly elevated rate of infections evident at first test day in the summer of 2009 and 2010, although the rolling 3 month average remains above the target for all 18 months shown above.

The dry period new infection and cure rate both show the same strong seasonal variation. It is apparent as dry period new infection rate increases the dry period cure rate show the

opposite trend with a fall. This would be consistent with a relatively constant true dry period cure rate, with apparent cure rate being depressed by new infections during the summer months (when new infection rate is high). This would support an environmental aetiology in this SCC pattern.

11.6.3.3 1st 30 day clinical mastitis rate

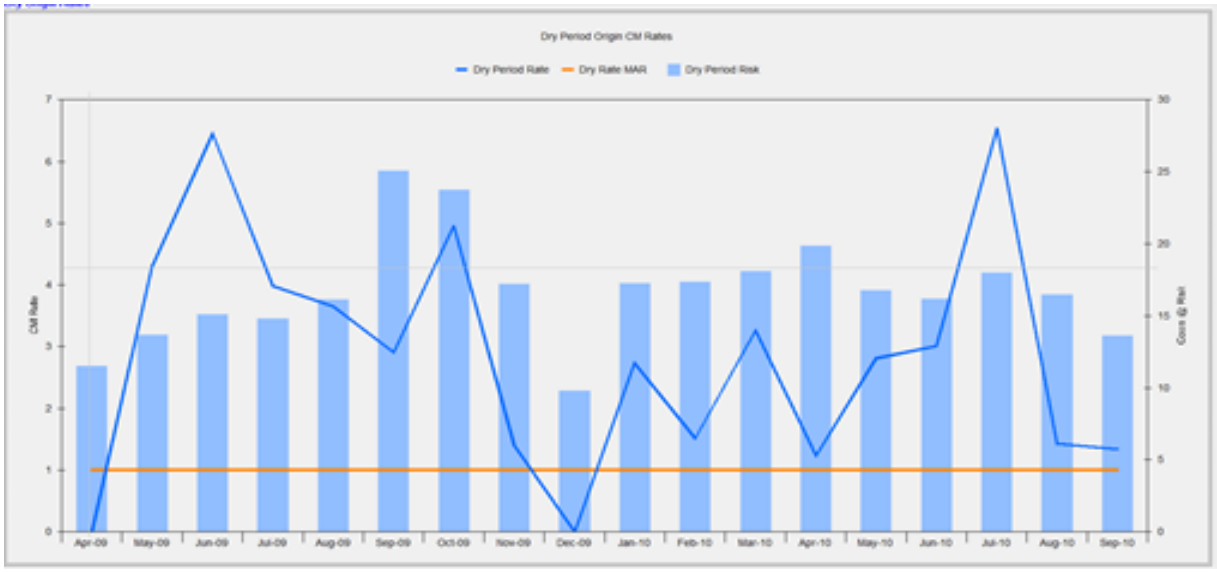


Figure 2 - Rate of new clinical mastitis cases in the first 30 days (i.e. likely dry period infections): *The blue bar indicates the number of cows at risk i.e. within 31 days after calving. The blue line indicates the rate of cows obtaining a new clinical mastitis case in that period. The orange line is a 'target' set at a rate of 1 cow affected per 12 cows calving.*

11.6.3.3.1 Comment

The IRCM in the first 30 days shows a strong seasonal pattern with a peak occurring in May 2009, which did not decrease until winter 2009. The rate remains above target, except in December 2009 when only ten cows calved. The rate then spikes in early summer 2010 and rises to a peak of nearly seven times the target (orange line).

Clinical mastitis rate by month since calving was also examined and the majority of CM cases were occurring during the first 30 days of lactation relative to every other month. This may suggest that infections were arising from both the dry period and also in the fresh cow housing.

The pattern of recurrence of CM over the previous two year period up to June 2010 was also investigated. Over 50% of the 127 animals affected with mastitis had only one incidence.

There was a large drop between first and second incidences, with less than 20% having two cases of CM. This would suggest a minimum 50% clinical case cure rate and supports an environmental aetiology for CM within this herd; but also possibly prompt identification and effective treatment of CM cases.

11.6.3.4 Bacteriology (august 2010)

Twelve cows with clinical mastitis (CM) were sampled pre-treatment.

COW ID & QUARTER	DAYS IN MILK	BACTERIA
60 FR	5	CONTAMINATED
69 BL	25	E. COLI
71 FL	35	CONTAMINATED
81 BR	17	STREP UBERIS
373 BR	7	CNS
401 FR	3	E. COLI
501 BR	26	CNS
638 BR	12	STREP UBERIS
659 FL	9	STREP UBERIS
692 BR	29	STREP UBERIS
705 BR	30	STREP UBERIS
785 BL	45	E. COLI

Table 2 - Bacteriology (August 2010): the above table illustrates the results of bacteriology performed on clinical mastitis samples which were taken from freshly calved cows in August 2010. These samples were taken by the farmer on veterinary advice once it had been decided an investigation would be performed; CNS – coagulase negative staphylococci.

11.6.3.4.1 Comment

The predominance of environmental pathogens such as *Escherichia coli* and *Streptococcus uberis* in 8 out of 12 clinical mastitis samples in early lactation with all but one of these being within 30 days of calving would suggest an environmental aetiology with most infections arising in the peri-parturient. The presence of CNS in two of the CM samples is surprising as a cause of CM; though it can cause CM it is more likely present as a contaminant due to poor sampling as it is a teat skin commensal.

11.6.4 Diagnosis

The epidemiological patterns demonstrated in the above tables and figures demonstrate this farm has an udder health problem manifesting in both CM and SCC caused by environmental pathogens with infections occurring during the peri-parturient period representing the bigger problem.

11.6.5 Immediate action

A DMCP questionnaire was completed to identify evidence based risk factors, in conjunction with a parlour visit and building assessment.

11.6.6 Economics

The costs of mastitis were worked out with the farmer using the Dairy Co Mastitis Cost Benefit Calculator Tool (Appendix 1). This was beneficial to help him realise the potential savings that could be generated from the investigation and implemented controls.

Annual costs of £21,218 due to CM and SCC (relative to the national average) are significant to any farm business. The predominant problem was the IRCM and was significantly elevated relative to the median of 47 – 65 cases / 100 cows /year established by (Bradley et al. 2007). Each case of clinical mastitis on this farm was estimated to be costing £234 and comparable to a previous studies cost of £201.23 (Esslemont & Kossaibati 2002). If the CM rate could be reduced by half to 44 cases/ 100 cows/ year, this would save the farm an estimated £10,296 per annum.

11.6.7 Management

On completion of the DMCP questionnaire, farm and parlour visit a large number of risk factors were identified. The risk factors were filtered using the DMCP software to select those, which have an effect on environmental dry period origin mastitis. This was to ensure that advice was focused on the area contributing most significantly to the problem. This herd had 26 risk factors identified from a possible list of 121 (Appendix 3).

Twelve targeted changes (see below) were then suggested from the total of twenty six identified risk factors on this farm. These risk factors were focused on as they were believed to be the control points which would have the greatest impact on farm and the farmer felt capable of implementing these interventions. The control points were limited to twelve as asking the farmer to implement more would have been difficult, may have reduced compliance and limited improvement in the on farm situation.

Long term management recommendations for the twelve control points identified as risk factors for the development of environmental mastitis of dry period origin in this herd investigation:

1) **DRY COW ENVIRONMENT: STRAW YARDS**
   a) There should be 1.25sq.m. per 1000 Litres of milk per cow/year of bedded area.
   b) The base of the straw yard could be covered with 6 inches of sand and then straw bedded. This would help to improve drainage and maintain dryness of straw bedding.
   c) Straw yards SHOULD be cleaned out completely at least once per month.
2) **SLURRY MANAGEMENT FOR DRY COWS**
   a) Alleyways, loafing and feeding areas SHOULD be scraped out at least twice daily.
3) **VENTILATION**
   a) Ventilation of the dry cow yard could be improved by creating an open capped ridge or creating an open ridge with up-stands to create a venturi effect and lift air up and out.
4) **FEED AREAS FOR DRY COWS**
   a) At least 4 ring feeders should be used to feed the dry cows or troughs purchased to allow each cow to have at least 0.6m of feed-space.
5) **PASTURE MANAGEMENT FOR DRY COWS**
   a) Cows should spend no more than 2 weeks in any one area.
   b) Cows should not return to a previous grazed area within 4 weeks.
6) **DRY COW TREATMENTS**
   a) You should follow the standard operating procedure I have provided for administering dry cow therapy.
   b) Cows SHOULD not be dried off during milking but separated and dried off when plenty of time is available later in a clean milking parlour.
7) **MANAGEMENT OF COWS AT CALVING**
   a) Every quarter should be stripped within 4 hours of calving to check for mastitis.
   b) The straw yard containing fresh cows and mastitic cows should be divided with groups separated. This should help reduce transmission of infection from infected cows to fresh cows.

11.6.8 Outcome

Following implementation of these recommendations and taking an iterative approach to mastitis management by 2013 this farm had a CM rate of 30 cases/ 100 cows/ year; suggesting as a result of six monthly reviews significant improvements had been made.

11.6.9 Discussion

The dry period is an important time for optimising udder health and milk quality with the aim of curing existing intra-mammary infections (IMI) and preventing the acquisition of new IMI (Neave et al. 1950; Eberhart 1986; A J Bradley & Green 2000; Dingwell et al. 2004). New IMI present at the first test day of a new lactation have significant financial implications as a result of deleterious effects on milk yield, quality, implications regarding antimicrobial use and also dairy cow welfare (Archer et al. 2013b; Archer et al. 2013a; Archer et al. 2014)

It has been demonstrated that of enterobacterial mastitis occurring in the first 100 days of lactation, 52.6% arose in quarters previously infected during the dry period and 92% of cows infected with *Streptococcus uberis* during the dry period developed CM in the first 120 days of lactation (A J Bradley & Green 2000; Oliver et al. 1998; Gillespie et al. 1998). Therefore the diagnosis of environmental pathogens of mostly dry period origin would seem logical as most CM cases were occurring within early lactation (Green et al. 2002).

There have been a number of UK based studies using bacteriology to measure cure rate across the dry period, which highlight that cure rates of at least 90% are possible even for *Staphylococcal aureus* (E. A. Berry & Hillerton 2002a; Bradley et al. 2010; Bradley et al. 2011; Newton, Green, Benchaoui, Cracknell, Rowan & A. J. Bradley 2008). It has been previously described that 63% of infections during the dry period self-cure, although in late summer/autumn 2009 this farm was only achieving a 60% cure rate (Huxley et al. 2002). Further research from over 7 million recordings in over 2128 herds demonstrated a cure rate across the dry period measured by SCC of 71.4%(Madouasse et al. 2010). This highlights the extremely poor performance of this herd and would support an issue with high infection pressure and new infection rates during the dry period, which are artificially lowering apparent dry period cure rate. This is also supported by findings that herds with poor cure rates across the dry period tend to have higher new infection rates (Madouasse et al. 2012). This herds rolling 12 month new infection rate was 24.4%, though research highlights the

mean new infection rates to be expected for cows and heifers are 10.0% and 18.5% respectively (Madouasse et al. 2010).

Milk bacteriology provided valuable information as to the aetiology of the problem. *Streptococcus uberis* was the most commonly encountered CM pathogen. Classically it is viewed as an environmental pathogen although recently some strains appear to behave contagiously (Peeler et al. 2000; Phuektes et al. 2001; Zadoks et al. 2001a; Zadoks et al. 2001b). How it acts is dependent on the farm management and the strains present (Zadoks & Schukken 2003). It has been associated with straw yards and pasture (Biggs 2004; Bramley 1982). Therefore peaks can be seen towards the end of summer when grazing or even during winter and summer within straw yards. *Coagulase negative staphylococcus* (CNS) was present in a number of CM samples. CNS colonises the teat end and is usually commensal to the teat skin though has also been considered to act as a primary pathogen (Blowey & Edmondson 2000). Others feel that its colonisation of the teat end predisposes to infection with *Streptococcus uberis* and *Escherichia coli* during the dry period (E. A. Berry & Hillerton 2002a). CNS can also cause transient infections around calving resulting in rises of the SCC (Blowey & Edmondson 1996). It is important not to over interpret its presence in these CM samples, as poor milk sampling technique may result in its culture due to it being a teat skin commensal.

Escherichia coli was present in a quarter of the CM samples and is classically viewed as an environmental pathogen. It also has the ability to develop subclinical infections during the dry period, causing mastitis later in lactation (A J Bradley & Green 2000).

Dry period performance was clearly a significant problem and the management shortfalls have been highlighted (Appendix 3). Herd-management factors related to the environment are significantly associated with increased rate of CM and SCC in early lactation. Environmental mastitis control must focus on steps to reduce infection pressure and maximise immune function. Poor farm hygiene is a herd factor identified by (Bradley et al. 2006) as a risk factor for new dry period intra-mammary infections (IMIs) and improved hygiene recommendations are often very specific.

For dry cows the provision of >1.25 m^2 per 1000kg of annual mean cow-milk production and even coverage of bedded areas has been demonstrated as significant risk factors for new

IMIs (Green et al. 2007; Green et al. 2008). Furthermore, pasture grazing policies that fail to limit grazing on one area to a maximum of 2 weeks without a return to the same area within 4 weeks are a risk. Research has demonstrated that *Streptococcus uberis* can survive for 2 weeks on paddocks under optimal conditions (Green et al. 2007; Green et al. 2008; Lopez-Benavides et al. 2007). Good ventilation is necessary to prevent moisture levels building up within straw yards and providing a micro-climate which allows rapid bacterial multiplication (Blowey & Edmondson 2000).

Un-hygienic application of dry cow therapy is another risk factor for the development of dry period origin IMIs and therefore was focused on (Appendix 2). Drying off during milking and failure to clean teats with surgical spirit during dry cow therapy administration significantly increases the risk of CM and SCC in early lactation (Bradley et al. 2006; Green et al. 2007; Green et al. 2008). Milk yield as part of the drying off technique was also discussed as this has been shown to increase the likelihood of a new IMI during the dry period or at calving (Dingwell et al. 2002; Huxley et al. 2002; Rajala-Schultz et al. 2005; Odensten et al. 2007; Newman, J. Rajala-Schultz, et al. 2009).

Failure to strip the udder within 4 hours of calving was significant as this could delay the time taken until treatment was instituted hence lowering the cure rate (Bradley et al. 2006). One of the most significant problems was the co-housing of the CM group with freshly calved cows. This could allow new infections to easily develop through contact; as *Streptococcus uberis* can behave contagiously (Peeler et al. 2000; Phuektes et al. 2001).

Restricted feed access has been shown to reduce feeding times and dry matter intake during the dry period. This increases the risk of cows developing metabolic disease after calving, which is known to significantly increase the risk of mastitis at this time. This effect is likely as a result of ketosis in early lactation impairing immune function (Huzzey et al. 2007).

11.6.10 Conclusion

This case study demonstrates the importance of good record keeping as it allowed a thorough investigation to accurately identify where problems were originating. It also highlights the need for targeted and tailored farm specific advice to achieve a successful outcome.

11.6.11 References

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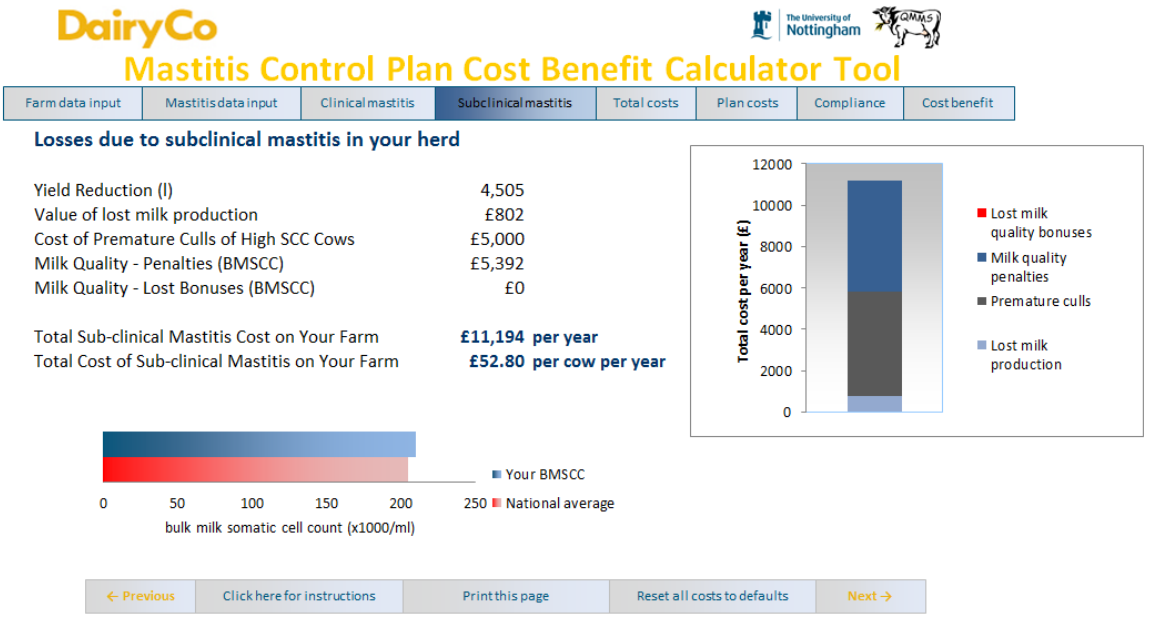
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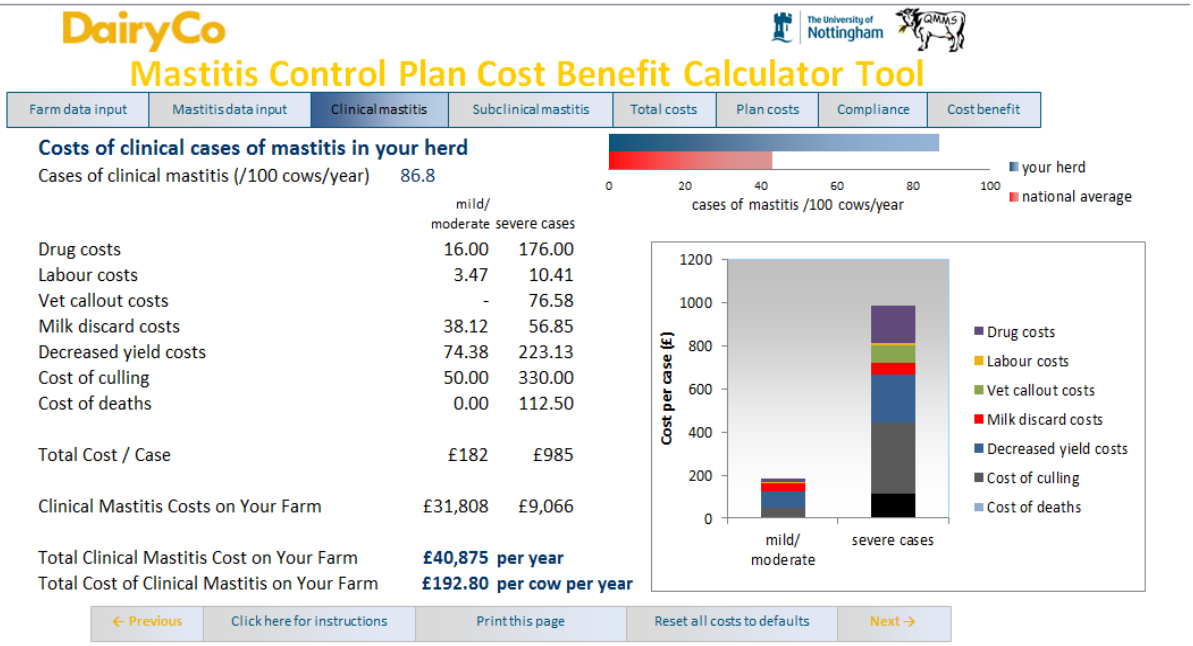
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11.6.11.1 Appendix 1

Calculations on the cost of CM, SCC and combined costs of mastitis for the farm described in this case study. These figures have been created using the Dairy Co. Mastitis Control Plan Cost Benefit Calculator Tool, which is an adjunct to the Dairy Co. Mastitis Control Plan. This aims to highlight the costs associated with mastitis in a visual format allowing easy interpretation for vets and farmers alike.





DairyCo

Mastitis Control Plan Cost Benefit Calculator Tool

Farm data input | Mastitis data input | Clinical mastitis | Subclinical mastitis | **Total costs** | Plan costs | Compliance | Cost benefit

Total mastitis costs in your herd

The total cost of mastitis in your herd is..

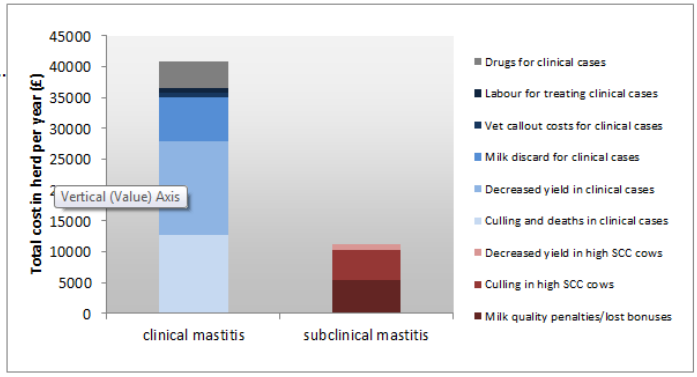
£52,069 per year

£245.61 per cow per year

2.9 ppl

Compared to national average, this is...
£21218 per year worse off in total.
£100.09 per cow per year worse off.

Compared to top 25% of herds...
£36997 per year worse off in total.
£174.51 per cow per year worse off.



← Previous | Click here for instructions | Print this page | Reset all costs to defaults | Next →

11.6.11.2 Appendix 2

A description of the areas discussed with the farmer to ensure drying off procedures were aligned with current evidence based recommendations.

DRYING OFF STANDARD OPERATING PROTOCOL

1. Ensure teats & udder are washed with clean water and dried thoroughly if dirty.
2. Wear a new set of nitrile gloves, preferably for each cow.
3. Start with teats on the far side of the udder:
4. Predip & leave for 30 seconds before being wiped with a dry towel.
5. Scrub the teat and teat end with a new piece of cotton wool soaked in surgical spirit until cotton wool comes away clean.
6. Take 6 strippings from the teat into teat cup & discard.
7. Repeat scrubbing of teat/teat end as above and allow to dry.
8. Partially insert cannula of dry cow tube and massage into the udder.
9. Scrub teat end again and allow to dry.
10. Pinch the teat base & infuse Orbeseal by partial insertion of cannula, when syringe nearly emptied withdraw and deposit small amount in teat canal.
11. Immediately apply post dip.
12. Repeat with teats on near side.
13. Dry cows MUST be confined to a clean loafing yard for at least 30 minutes to allow closure of the streak canal.

DRYING OFF RULES

1. Cows **SHOULD** be yielding less than 15 litres at drying off, preferably less than 10.
2. Drying off **MUST** be abrupt; that is cows should not be milked once daily.
3. Cows **SHOULD** not be dried off during the milking procedure but should be separated and dried off, when plenty of time is available, after milking.
4. Cows **SHOULD** be dried off in the parlour (but not during milking – clean parlour, plant off), since this gives best access for udder preparation.
5. Cows **MUST** not be dried off when foot-trimming.
6. **NEVER** touch the nozzle of DC tube/Orbeseal, if so discard syringe.
7. **NEVER** immerse syringes in water to warm up.

11.6.11.3 Appendix 3

A table highlighting all twenty six control points where the farm in this case failed, from the one hundred and twenty one in the Dairy Co. Mastitis Control questionnaire.

CONTROL POINTS	FARM ASSESSMENT
PREPARATION OF DRY COWS	
What is the minimum number of days before calving, when you dry cows off?	30 days
What is the highest daily yield at which you dry a cow off?	15 Litres
What is the minimum amount of milk (litres per day) that a cow needs to produce in order to avoid being dried off?	15 Litres
DRY COW ENVIRONMENT: STRAW YARDS	
There should be 1.25sq.m. per 1000 Litres of milk per cow	Early Dry Cows - Currently measured 19.5m by 6m in bedded area (117 sq.m.) and contained 15 cows. This meant it was overstocked as it should have only contained 12 maximum. Each cow had 7.8 sq.m. instead of 10.03 sq.m. Close – ups and fresh cows - Housed together with mastitis cows. Currently yard is 207 sq.m., which can fit 20 cows although has 21 at present, so overstocked also.
The base of the straw yard SHOULD have excellent drainage, possibly with sand on top of hardcore or concrete.	At present the straw yard had a hardcore base but was not based with sand on top of the hardcore below the straw.
On average, how many weeks are there between completely cleaning out your straw yards used for dry cows?	Straw yards were cleaned out fully every 6 weeks.
SLURRY MANAGEMENT FOR DRY COWS	

How many times per day do you scrape alleyways, loafing and feeding areas?	Once
VENTILATION	
There MUST be good ventilation, but without draughts in all dry cow housing,	The dry cows were kept in a large shed with plenty of inlet. The outlet was provided by a crown crank ridge which was insufficient in size. The inadequancy of the outlet was demonstrated through the use of smoke bombs.
FEED AREAS FOR DRY COWS	
There SHOULD be at least 0.6m feedspace per cow in total for access to forage, concentrate or complete diet portions of the cows' feed.	The fifteen early dry cows were provided with two ring feeders that contained 16 cow spaces. 16 cows could not fit around the ring feeders and 0.6m was not provided.
DRY COW NUTRITION	
The early dry cow ration energy density should be >8 MJ ME/kg DM and <11 MJ ME/kg DM.	The early dry cow group were provided with haylage during the winter. However, during the summer they are grazed. Summer grass can contain > 12 MJ ME/kg DM and therefore is not appropriate as cows could put on weight during the early dry period.
Do all early dry cows have an appropriate dry cow mineral supplement?	No
Feed management	The ring feeders for the early dry cows were not cleaned regularly. The food in the trough in the transition group was overheating on examination and not cleaned out regularly. This was affecting

	the palatability of the fresh food provided daily.
PASTURE MANAGEMENT FOR DRY COWS	
What is the maximum number of continuous weeks that dry cows spend on the same pasture, paddock or field?	3 weeks
What is the minimum number of weeks you allow before returning dry cows to any one grazing, loafing or rest area after it has been used by cattle?	>1 week
DRY COW TREATMENTS	
Do you administer Dry Cow Therapy as detailed in the standard operating procedure provided?	No
Do you ever dry cows off during the milking process?	Yes
YARDS AND PENS FOR CALVING COWS	
Do all cows calve in individual calving pens?	No
BEDDING MANAGEMENT FOR ALL CALVING COWS	
On average, how many weeks are there between completely cleaning out your straw yards used for calving cows?	6 weeks
MANAGEMENT OF COWS AT CALVING	
Do calves have the opportunity to suckle other cows as well as their dam?	Yes
How many times in the first 24 hours after calving do you normally check cows for signs of mastitis or other disease?	Once
Do you strip every quarter within 4 hours of calving to check for mastitis?	No

Do you use the California Mastitis Test (CMT) to check all quarters of each cow for mastitis within 7 days of calving?	No
What is the maximum number of hours after calving that a cow might wait before being milked for the first time?	24 – 36 hours.
Freshly calved cows were not grouped separately.	Transition cows were housed with cows under treatment for mastitis as these were kept as a separate group to the main herd.
TEAT SCORING	
There should be less than 5% of cows with moderate/severe teat end damage (hyperkeratosis).	No
COW CLEANLINESS	
Dry cows should meet cleanliness targets.	No

11.6.11.4 Appendix 4

A list of definitions of indices described within the text of this case report.

LACTATION NEW INFECTION RATE

The rate at which uninfected cows (SCC < 200,000 cells/ml) at the last milk recording develop new infections (SCC > 199,000 cells/m) at the next milk recording. A maximum advisable rate (MAR) is suggested at 5%, *ie* 1 in 20 uninfected lactating cows exceeding the 199,000 cells/ml threshold each month, every month.

HIGH SCC COWS

The prevalence of infected (≥ 200,000 cells/ml) and chronically infected (two of the last three SCC ≥ 200,000 cells/ml) cows as a percentage of the milking herd.

FRESHLY CALVED INFECTION RATE

The percentage of cows (and heifers) that have calved since the last recording and sampled for the first time in lactation that report a SCC ≥200,000 cells/ml or were absent from the milk recording due to clinical mastitis. The maximum advised rate (MAR) in this case is 10%.

DRY PERIOD NEW INFECTION RATE

Similar to the freshly calved infection rate but this report shows the rate of new dry period infections, *i.e.* the proportion of cows (and heifers) calving down infected (SCC ≥ 200,000 cells/ml) each month that were uninfected (SCC < 200,000 cells/ml) at drying off. The maximum advised rate (MAR) in this case is 10%.

DRY PERIOD CURE RATE

The rate of dry period cures, *ie* the proportion of cows (not heifers – these are assumed to be uninfected at calving) calving down uninfected (SCC < 200,000 cells/ml) each month that were infected at drying off. Target ≥ 85%.

THE RATE OF NEW CLINICAL CASES OF APPARENT LACTATION ORIGIN

The incidence rate of first (index) cases occurring in lactation (*i.e.* > 30 days in milk). The MAR is set at 2 cases in 12 cows at risk over a 10-month lactation period (i.e. 2 in 12 cows get mastitis of lactation origin in each lactation) (Bradley & Green 2006).

THE RATE OF NEW CLINICAL CASES OF APPARENT DRY PERIOD ORIGIN

This report plots the incidence rate of first (index) cases occurring from the dry period (*i.e.* <31 days in milk). The MAR is set at 1 case per 12 cow 'blocks' of 30-day risk periods (i.e. 1 cow in 12 gets mastitis in the first 30 days after each calving) (Bradley & Green 2006).

11.7 Appendix 3 – Bovine Viral Diarrhoea Investigation

ANDREW HENDERSON

ECBHM CASE REPORT 3

11.7.1 Case summary

A dairy client who was visited on a monthly basis decided further surveillance for the presence of bovine viral diarrhea (BVD) should be carried out on his farm with the aim of BVD eradication. This was prompted due to a discussion with a neighbouring dairy farmer, who had recently experienced problems with BVD.

11.7.2 Background information

The herd comprised 107 Holsteins calving all year round. The herd was split into an early and late lactation group and fed a partial mixed ration. The early lactation group were bred using artificial insemination and the late lactation group bred with a Limousin sweeper bull. Heifer replacements were reared on farm and had close contact with the adult dairy herd. Vaccination had been performed for bovine viral diarrhea virus (BVDV) and leptospirosis for the last 10 years. The herd had not purchased any cattle for the last 5 years, although was situated in a high cattle density area with 6 other dairy farms within close proximity and potential for nose to nose contact at farm boundaries.

11.7.2.1 Farm data analysis

11.7.2.2 Infectious Disease

DATE	20.4.11	5.8.11	15.12.11	7.3.12	15.6.12
BVD ANTIGEN	Negative	Negative	Negative	Negative	Negative

Table 1 - Bulk Tank BVD antigen PCR results over the previous 14 months.

Bulk milk screening had been performed every quarter for the previous 14 months and the most recent five results (Table 1) suggested it was unlikely the herd contained an animal persistently infected (PI) with BVD. However, it must be remembered that these tests do not take account of animals not contributing to the bulk milk tank on day of sampling.

11.7.2.3 Initial problem

A meeting was arranged on farm to discuss the characteristics of BVD and how the farm would like to proceed with further testing. Discussion was had with the client as to whether he wanted to achieve Cattle Health Certification Standards (CHeCS) for ultimate eradication of BVD and UK and Ireland industry recognition of BVD free status. The client was not concerned with being part of a regulated nationally approved eradication scheme as he was not a pedigree registered herd requiring approved free status or looking to sell BVD free heifers at a market premium to other dairy farmers.

It was decided the current milking herd did not require further investigation as the last five tests had been BVD antigen negative. To ensure a persistently infected (PI) dry cow was not missed it was agreed bulk milk antigen testing must be continued precisely every 3 months. This could possibly result in an individual being missed, though was the best compromise for surveillance as 4 tests per year costed £100.

Previous and current surveillance/diagnostic testing had not been targeted at the youngstock. Therefore, it was decided that cohort testing of maiden heifers would be undertaken to achieve surveillance of the youngstock for the presence of BVD infection.

11.7.3 Immediate action

Before, cohort testing was embarked upon it was felt that a sample size calculation should be performed. This was performed to estimate the sample size required based on an 80% certainty of detecting a true prevalence of >=0.014 (Houe, 1999). Using a population of 270 youngstock present on farm, the sample size calculation estimated 10 animals should be tested (AusVet, 2016).

A total of 10, 11 – 12 month old heifers were blood sampled and tested using an antibody ELISA. These screening tests highlighted 8 animals to be sero-positive for BVD antibody (Appendix 1). The 2 animals, which were negative were tested for BVD antigen and confirmed negative, suggesting they were not PIs. These results strongly suggested this group of animals had been in contact with a PI or PIs in the last 12 months. This indicated a strong likelihood of active BVD infection on farm at present. However, it could not be guaranteed that the possible PI or PIs had already died and been removed from the farm.

11.7.4 Diagnosis

Active BVDV infection.

11.7.5 Management

11.7.5.1 Testing

It was recommended to the farmer that he should test all youngstock on farm to identify PIs as they were in close contact with the adult herd due to housing restrictions. At the same time he was instructed to test all calves born on farm until at least 12 months after removal of the last PI.

BVD tissue ELISA tags were decided on as the most appropriate method of testing as the farmer could perform this without the cost of veterinary labour and calves could be tested at birth (this was inclusive of all abortions and stillbirths). Testing highlighted the presence of 3 PIs on farm from a total of 270 youngstock.

All PIs once identified were isolated and retested 3 weeks later to confirm they were persistently rather than transiently infected. These animals were then culled. All dams of PIs were also tested; none were found to be PIs.

11.7.5.2 Biosecurity

A review of biosecurity was undertaken, which highlighted nose to nose contact was possible at farm boundaries with neighbouring stock. A suggested improvement was to consider double fencing boundaries with a 3 metre gap to prevent or minimize the risk of nose to nose contact.

If this was not possible it was recommended that grazing next to neighbouring stock should be avoided if possible during the summer.

11.7.5.3 Vaccination

BVD Vaccine (Bovilis BVD®, MSD) was being used by the farmer to ensure protection of his herd. This is a dead vaccine and requires a primary course of two injections 4 weeks apart followed by a 6 monthly booster; the primary course must be completed at least 2 weeks prior to first service to ensure fetal protection. On investigation maiden heifers were found to only receive their primary course after first service. This made foetal infection more likely if this group was exposed to a PI and it was felt this was a likely point of entry of BVD into the herd.

11.7.6 Economic considerations

Item	Costs
BVD testing (Laboratory Fees)	£719.4
Veterinary Fees	£187.5
All testing (270 youngstock)	£906.9
Vaccination per Year	£432.50 *115 cows booster and 29 heifers primary course.
Rearing 3 heifer replacements	£3840 (Dairy Co., 2012)
Cull Income of PIs	£0

Table 2 – An illustration of the cost associated with a BVD control program with specific reference to the herd in the case study.

The costs of BVD can be very difficult to calculate due to the varying situations present on each farm. This makes it extremely difficult to categorize herds and assign a cost to each category. Costs may be influenced by the immunity of the herd, the risk of infection being introduced, strain virulence and management of stock on farm. Previous estimates of BVD costs on farm

have reached similar conclusions to the costings highlighted in Table 2. Wolf (2007) state the mean cost per calving can range from £3.90 – 34.80 in herds where existing infection is present. Stott, Humphry, Gunn, Higgins et al. (2012) estimate the cost of BVD within Irish dairy herds to be £37.10/cow and the cost benefit ratio to be in favour of eradication by a factor of 14.

The costs in this herd could have initially been suggested to be low as vaccination has been carried out for the last 10 years. However, due to the risks of introduction of infection from neighbouring farms and unstrategic vaccination they inevitably are much higher.

Using an estimate of £20 per cow per year in this herd seems realistic as this herd is mitigating the majority of the profitability risks by vaccinating, therefore a low end cost is more likely. This estimate is also more or less in the middle of Wolf's (2007) estimate and over 10 years, BVD could cost this farm £23,000. Combining the cost of the testing implemented to remove PIs, vaccination and monitoring over 10 years should cost in the region of £5500. This would suggest the cost:benefit is in favour of BVD eradication, though enhanced biosecurity would also be necessary. Biosecurity improvement will also have an additional cost with the main weakness being discussed previously. However, the cost of appropriate fencing could actually eliminate the benefit of an eradication program in this herd and many others.

11.7.7 Discussion

11.7.7.1 Virology

Bovine Viral Diarrhoea (BVD) is one of the most economically important viral diseases of cattle both in the UK and worldwide (Booth and Brownlie, 2012). BVD virus is part of the family Flaviviridae and genus Pestivirus and is a single stranded enveloped RNA virus (Kelling, 2004). It consists of two genotypes, Type 1, which can be further subdivided into 1a and 1b and Type 2 (Kelling, 2004). Type 1 is the most common type in the UK and was responsible for issue present on the farm in this case study. Type 2 was first isolated in the UK in 2002 and is only found intermittently (Sandvik, 2007) (Drew, David and Steinbach, 2007). Both genotypes can vary in pathogenicity as a result of antigenic variation between strains within the genotypes, though Type 2 tends to be more pathogenic than Type 1 causing a haemorrhagic syndrome

(Thiry, 2007). As Type 1 does not confer any immunity for Type 2 outbreaks may become more common in the UK, and tend to have a high case fatality rate (Sandvik, 2007; Radostotis, Gay, Hinchcliffe et al., 2007). BVD can further be divided into two biotypes, non-cytopathogenic (NCP) and cytopathogenic (CP). NCP is the most common type, causing acute infection and also crossing the placenta resulting in the production of PIs (Radostits et al., 2007). CP arises as a result of mutation of NCP in PIs, resulting in recombination of biotypes and super-infection with CP and the development of mucosal disease, which had not been evident in this herd at the point of investigation (Thiry, 2007).

11.7.7.2 Clinical effects

The outcome of an infection depends on the status of the animal when exposed to BVD. Economic losses associated with the disease are usually due to decreased fertility, and immunosuppression resulting in an increased incidence of respiratory and enteric infections within youngstock (Booth and Brownlie, 2012). Bovine respiratory disease and enteric infections were anecdotally prevalent on this farm, though no disease event records were kept to analyse the level to which this existed.

70 – 90% of acute infections are not clinically evident although associated signs include pyrexia, lethargy, anorexia, oral lesions, oculonasal discharge, diarrhoea and decreased milk yield (Radostits et al., 2007; Ames, 1986). Clinical signs may last for 2 – 4 weeks and viraemia up to 15 days (Evermann & Barrington, 2005). This farm had regular monthly fertility visits and even though BVD was present there were no reports of clinical signs. This is supported by Smith and Grotelueschen (2004) who state that the determination of herd status on clinical evidence is neither sensitive nor specific; though this herd was vaccinating and this may have limited the expression of clinical signs in the adult herd.

Acute infection directly affects fertility with Grooms et al. (1998) demonstrating that growth and diameter of dominant follicles was reduced by acute infection. The most significant effects are seen when infection occurs during or soon after breeding rather than before (Evermann and Barrington, 2005). Ridpath, Bolin and Dubovi (1994) also demonstrated a reduction in conception rates from 79% to 33% in association with BVD infection. Sub-optimal pregnancy rates were being experienced on this farm with an average of 25% in the past year. This is well

below a reported mean of 37% (median 37%, IQR 32 – 41%) from a recent large UK dataset of over 400 dairy farms (Hudson et al., 2010). Pregnancy rates in heifers were 50%, which is sub-optimal compared to suggested target of >50% for first service (Breen et al.,2012).

Acute infection can result in abortion, most commonly seen at less than 125 days gestation, although expulsion may occur many months later (Olafson, McCallum and Fox, 1946; Duffell, Sharp and Winkler, 1984; Roeder, Jeffrey and Cranwell, 1986). Late embryonic losses demonstrated by elevated return to service intervals of 25 – 35 days had been evident on this farm. It was estimated that 5% of pregnancy diagnoses made from 30 - 42 days on this farm during the previous 3 months had later been resorbed or expelled. Expected levels of late embryo loss is estimated at 7% for the period between 21 – 42 days and could be suggestive of a potential issue on this farm, atrributable to BVD (Diskin and Morris, 2008). Though, the main factors normally implicated are genetic, physiological, endocrine and environmental in origin (Diskin and Morris, 2008) and would suggest other factors should also be investigated in this herd.

If abortion does not occur congenital defects can arise dependent on the stage of organogenesis (Smith and Grotelueschen, 2004). These defects were not a common presentation on this farm. BVD can be immunosuppressive to the innate and acquired immune systems resulting in respiratory and enteric infections in youngstock (Chase, Elmowalid and Yousif, 2004). The anecdotally high prevalence of respiratory disease on this farm was potentially a direct result of circulating BVD infection due to its synergistic effect with respiratory pathogens such as *Mycoplasma bovis* and *Pasteurella multocida*.

11.7.7.3 Testing

Diagnostic testing found 3 PIs in a total of 270 animals. This represented 1.1% of the herd. The prevalence of PIs has been demonstrated to be 1.9% and 1.4% by Houe (1995) and Houe (1999) respectively in dairy herds. PIs are created when foetal infection occurs between 45 – 125 days of gestation (Smith and Grotelueschen, 2004). Prior to foetal immune system development at 125 - 175 days the foetus recognizes BVD virus as ‘self’ antigen so no immune response is mounted. As a result PIs are by definition virus positive and antibody negative. Many succumb to mucosal disease between 6 – 24 months of age with 50% dying within their first year of life

(Smith and Grotelueschen, 2004). As PIs are continually excreting BVD virus, they can almost be guaranteed to be produce PI offspring. As such BVD can be passed down familial lines and this is why all dams of suspect PIs were tested.

On this farm bulk milk sampling had been carried out as close to every 3 months as possible for a considerable period of time. Bulk milk antigen PCRs are reliable for detection of >=1 PI in up to 300 cows (Jones, Unknown). This herd had only 90 cows regularly contributing to the tank, therefore this test would be reliable in this herd. This only accounts for cows contributing to the tank on that day and is why testing was performed regularly to ensure all cows were subject to testing. The lactating herd is the least likely subpopulation in the herd to contain a PI (Smith and Grotelueschen, 2004). This is why screening of youngstock between 9 – 18 months, which act as sentinels, was performed. Sampling of as few as five sentinel animals has been shown to be at least 97.7% sensitive and 95.2% specific for predicting the presence of PIs (Smith and Grotelueschen, 2004).

Ear tissue antigen ELISA testing was chosen as the desired method for eradication as it was easy for the farmer to carry out and allowed easy identification of tested animals. Antigen ELISA would not routinely be used for animals under 6 months of age due to the presence of maternally derived antibodies (MDA). Antigen ELISA detects non-structural proteins, which are not antigenically privileged and hence are not available for detection due to complexes forming with MDA. Ear tissue is not very well supplied by blood, meaning MDA can be avoided. False negatives can arise if tissue samples are contaminated with blood. Hence it is important to reinforce to farmers that if blood contamination occurs then the sample should be discarded.

11.7.7.4 Control

Control of BVD within a herd consists of three main areas according to Fulton (2005). These include identification and removal of PIs, biosecurity/biocontainment and strategic vaccination. However, appropriate sampling on farm to determine the presence of BVD is also required. Once all four points have been addressed, implementation of continual monitoring is essential to demonstrate future freedom from disease. Future surveillance testing was discussed and the need to test all calves born for 12 months after the removal of the last PI was explained to

ensure further PIs present in utero would be identified. Future surveillance would involve only cohort testing of maiden heifers for antibody once the herd was considered free from disease. The herd is closed so there will be no new introductions to test which helped to simplify future control.

11.7.8 Conclusion

This case study highlights the need for education of farmers regarding vaccines limitation in the control of BVD (Smith and Grotelueschen, 2004). Vaccines must be handled appropriately and administered at the correct time. Though, we must also ensure appropriate surveillance strategies are implemented.

A strategic approach is required to tackle the presence of BVD. For long term eradication a national approach is required due to the high stocking densities of cattle in Britain, potential for sale of PIs between farms and poor biosecurity.

11.7.8.1 Appendix 1

REPORT 1 (FINAL)

LABORATORY FINDINGS

Sample	BVD Ab ELISA OD Ratio (modified method) (†)
1001	1.02
1003	1.44
1011	1.59
1013	0.05
1019	0.00

1) 1013 + 1019 need Ag testing to check NCA PI's.

BVD Antibody ELISA OD Ratio Interpretation:
<0.2 Negative, 0.2-0.3 Inconclusive, >0.3 Positive
A positive ELISA result indicates previous exposure and seroconversion to BVD virus. It is not possible to determine when this exposure occurred, or if it was associated with abortion.
A negative ELISA indicates that the animal has not been exposed and seroconverted to BVD virus, or that the cow is persistently infected.

REPORT 1 (FINAL)

LABORATORY FINDINGS

Animal ID	BVD Ab ELISA OD Ratio (modified method) (†)
200974	1.83
300982	0.66
600978	2.06
600985	1.52
700979	2.26

BVD Antibody ELISA OD Ratio Interpretation:
<0.2 Negative, 0.2-0.3 Inconclusive, >0.3 Positive
A positive ELISA result indicates previous exposure and seroconversion to BVD virus. It is not possible to determine when this exposure occurred, or if it was associated with abortion.
A negative ELISA indicates that the animal has not been exposed and seroconverted to BVD virus, or that the cow is persistently infected.

REPORT 1 (FINAL)

LABORATORY FINDINGS

Sample	BVD Ag Erns ELISA Result (†)
1013	Negative
1079	Negative

BVD Antigen Erns ELISA
This ELISA is capable of detecting both Bovine Virus Diarrhoea (BVD) and most strains of Border Disease (BDV) viral antigen. However, BDV infection is rare in cattle.

11.7.9 References

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11.8 Appendix 4 – Bovine Enucleation

ANDREW HENDERSON

ECBHM CASE REPORT

11.8.1 Summary of Case

A farmer with a 40 cow beef suckler herd presented a cow at a whole herd tuberculin test showing signs of ocular discharge.

11.8.2 Background Information

11.8.2.1 History

A 6 year old Hereford cross female, which was 5 months in calf to the herd's Belgian Blue/Simmental cross bull was presented. Ocular discharge had been noted by the farmer 4 months previously. The cow had been administered oxytetracycline 20% (Alamycin LA®, Norbrook) intra-muscularly at a dose rate of 1ml per 10kg. This had been given twice at a 48 hour interval. This resulted in short term resolution of the ocular discharge although it returned and the eye gradually worsened until the cows were brought in for their annual tuberculin test.

11.8.2.2 Clinical examination

The cow was restrained in a crush and a halter placed on the head so the cow's head could be tied laterally to the side of the crush to allow safe examination of the left eye.

Thickening, swelling and ulceration of the whole lower eyelid were present on the inside of the eyelid and the limbus, with the lesion measured 2cm by 5cm. Keratitis was evident on the corneal surface, as was epiphora and purulent discharge from the area of the lower eyelid and crusting of this over the face of the cow. The eyelids were closed over, exhibiting signs of blepharospasm and the cow resented examination due to the painful nature of the condition.

Proxymetacaine Hydrochloride 0.5% (Minims®, Bausch and Lomb UK) was used to provide local analgesia of the eye to allow closer examination of the eye. No foreign bodies could be visualized beneath either eyelid or nictating membrane and within the eyeball itself. A full clinical examination of the cow was performed and nothing abnormal was detected. Evidence of enlargement of the parotid lymph nodes was not found, which could be suggestive of metastatic spread.

11.8.2.3 Differential diagnosis

- Ocular squamous cell carcinoma.
- Lower eyelid trauma with secondary infection.

11.8.2.4 Clinical pathology

Three punch biopsies were taken from the eyelid and surrounding tissues on the initial examination to confirm diagnosis. Treatment would not have been altered on the basis of the result as the animal appeared in extreme pain; though it was felt important to confirm the causal factor. Results of the biopsies were obtained two weeks later confirming a squamous cell carcinoma.

The report described the presence of elongated and invasive cords of squamous epithelium extended haphazardly throughout the tissue. Infiltrative cords of neoplastic cells demonstrated hyperchromatic nuclei, pleomorphism, numerous mitotic figures and lack of polarity, with disruption of the basement membrane. Keratin pearls and intercellular bridges were also evident.

11.8.3 Diagnosis

- Ocular squamous cell carcinoma (SCC).

11.8.4 Immediate action

Enucleation of the eye was recommended to the client due to the extensive damage present to the eye and the surrounding tissues. Lesion excision would be difficult and may not remove all the SCC due to its invasive nature. The cow was likely to be suffering from considerable pain and distress compromising its welfare and this needed to be satisfactorily resolved. The surgery was arranged to be performed at the reading of the tuberculin test three days later. In the meantime the cow was administered with amoxicillin (Amoxypen LA®, MSD) 1ml per 10kg intramuscularly to control the secondary infection present and meloxicam (Metacam®, Boehringer Ingelheim) 2.5mls per 100kg subcutaneously to alleviate pain.

The client agreed with the recommendations as it would allow the cow to calve, rear the calf and fulfil further years of productive life.

11.8.5 Treatment

11.8.5.1 Surgical technique

- The cow was restrained in a crush with a head lock in a standing position.
- Two halters were placed on the cow's head and it was tied laterally to the side of the crush ensuring the cow could not move its head.
- As large an area as possible was clipped around the eye to prevent contamination of the surgical site and ensure enough skin is present for wound closure.
- Aseptic preparation of the skin was performed using povidone-iodine (Vetasept®, Animalcare) and warm water.
- An auriculopalapebral nerve block was performed using 5mls of procaine (Willcain®, Dechra). This was to make a retrobulbar block easier by removing upper eyelid motor function.
- A two point retrobulbar block was performed using procaine (Willcain®, Dechra) and a 19 gauge 3.5 inch curved spinal needle.
- A forefinger was placed into the lateral canthus to displace the globe to the side and the needle placed through the conjunctiva until the needle is retrobulbar. Aspiration was first performed to ensure no blood is present. Local anaesthetic was deposited at the optic nerve and then slowly infused as the needle was withdrawn. 30mls was used.
- This was repeated at the medial canthus.
- 2.5 mls of procaine (Willcain®, Dechra) was then infused 2.5cm in both eyelid margins as a ring block because a retrobulbar block does not result in complete eyelid analgesia.
- Amoxicillin (Amoxypen LA®, MSD) at a rate of 1ml per 10kg intramuscularly and meloxicam (Metacam®, Boehringer Ingelheim) at a rate of 2.5mls per 100kg subcutaneously was administered pre-operatively.
- The upper and lower eyelids were then apposed using a simple continuous suture pattern.
- An elliptical incision was then made into the skin 1 – 2 cm from the eyelids.
- Blunt dissection was performed using a pair of Mayo scissors to undermine the skin of the eyelid whilst avoiding the conjunctival sac.
- This was continued until all the extraocular muscles within the orbit had been separated from their attachment.
- Once the eyeball was freed a pair of curved forceps was placed across the optic curve and it was cut near the eyeball.

- On removal of the eyeball any remaining muscle, adipose tissue or diseased tissue was removed. The bony orbit was then examined for any neoplastic involvement of which there was none.
- The socket was then packed with sterile gauze until the small amount of bleeding present had resolved.
- The subcutaneous tissue attached to the bony orbit was then stitched using a simple continuous pattern with 7 metric catgut (Catgut chrom™, SMI). This was to relieve tension on the skin sutures.
- The skin was closed using 6 metric nylon (Supramid™, Dunlops) in a simple continuous pattern.

11.8.5.2 Sequelae

- The cow was administered with Amoxicillin (Amoxypen LA®, MSD) at a rate of 1ml per 10kg intramuscularly 48 hours post – operatively to finish its course of antibiotics.
- Skin sutures were removed 21 days after surgery with no evidence of discomfort or infection.

11.8.6 Economics

The total cost of the operation was £262.89 including time, surgical kit, local anaesthetic, antibiotics and NSAIDs. The estimated dead weight cull value of this cow is £750 (EBLEX, 2012) and the calf within it holds a significant value. The mean post surgical survival time is reported to be 15 months by Potter (2007) quoting Hirsbrunner, Ebeid and Eicher (1998) and by Anderson and Schulz (2010), which suggests this was a worthwhile procedure in this instance.

11.8.7 Discussion

Enucleation of the eye is probably the most common orbital surgical procedure performed by veterinarians in food animal practice (Schulz & Anderson, 2010). This refers to removal of the globe alone, although what most commonly happens is extirpation or exenteration meaning the removal of the globe, adipose tissue and muscle within the bony orbit (Potter, 2007; Schulz & Anderson, 2010). Common indications for this procedure include incurable ocular trauma with or without rupture of the globe as a result of primary infection or associated with secondary infection leading to panophthalamitis or staphyloma (Weaver, St Jean and Steiner, 2005; Potter, 2007). However, the most frequent is ocular squamous cell carcinoma (OSCC) or “cancer eye” (Potter, 2007; Tsujita and Plummer, 2010) as present in this case.

OSCC is a primary neoplasm of epithelial surfaces and occurs spontaneously (Tsujita and Plummer, 2010). It is the most common malignant tumour of cattle in North America being reported as 82% and 66% of condemnations at slaughter for neoplasia in the USA and Canada (Heeney and Valli, 1984). Reports are also frequent in Australia ranging from 8 – 45% in some herds (Sloss, Smith & De Yi, 1986; Tsujita and Plummer, 2010). In the UK and Europe it is much less common with a reported incidence of 0.04% in Holland based on the examination of 35,000 animals compared to 0.92% in Canada (Tsujita and Plummer, 2010; Hamir, and Parry, 1980). It is still a significant disease due to the economic losses experienced due to early culling, which would've occurred in this case without surgical intervention. But, also due to condemnation at slaughter with Heeney and Valli (1984) reporting that OSCC resulted in 12.6% of bovine carcasses being condemned in the USA (Tsujita and Plummer, 2010).

The high incidence in the USA particularly in south western regions is proposed to be due to lower latitudes with higher levels of sunlight (Tsujita and Plummer, 2010). Although the development of OSCC is multifactorial there is evidence that UV radiation associated with high levels of sunlight is a significant cause and would explain the comparatively low incidence in Northern Europe (Tsujita and Plummer, 2010). It has been suggested this is due to damage to p53 tumour suppressor gene with p53 accumulation being common in the nucleus of cells of OSCC (Tsujita and Plummer, 2010).

Bovine herpes virus (BHV) has a proposed involvement in the development of OSCC although this needs further investigation to confirm. The BHV status of this cow and the herd was not investigated and therefore is unknown. Furthermore, bovine papillomavirus (BPV) has also been suggested to be involved. It is thought that BPV may initiate events although does not maintain the tumour (Tsujita and Plummer, 2010).

Nearly all breeds of cattle are susceptible to OSCC, but Hereford and Hereford crosses are predominantly affected by OSCC with white faced Herefords most frequently; as was this case. This is due to their genetic tendency towards white faces but also as a result of being the predominant range breed (Tsujita and Plummer, 2010).

Corneoscleral and lid pigment are heritable and genetically associated, although pigment presence is not genetically related to the development of OSCC. The presence of pigment is photo-protective with more pigment lessening the susceptibility and probability of lesion development (Anderson, 1991). In

many studies it has been shown that tumours in incompletely pigmented areas usually begin in the unpigmented areas (Tsujita and Plummer, 2010).

The most common sites affected are the lateral conjunctiva and corneolimbal junction with lower and 3rd eyelid tumours being the most invasive and likely to metastasize (Tsujita and Plummer, 2010). In this case, the whole of the lower eyelid was severely affected and due to the likelihood of metastatic spread, a thorough clinical examination was performed with particular focus on palpable lymph nodes especially the parotids.

Peak incidence of disease occurs between 7 and 8 years of age with it being rarely reported in younger animals. Culling rates have also been demonstrated to increase until a peak between 7 and 9 years of age. This is probably related to the fact that older animals will have more opportunity to be exposed to initiating factors over time (Tsujita and Plummer, 2010; Heeney and Valli, 1985).

Sex is not thought to be related to incidence even though this is seen most commonly in females. This is as a result of males being slaughtered at a young age and suckler herds being predominantly of female gender (Tsujita and Plummer, 2010; Henderson and Valli, 1985).

OSCC may spread into the bony orbit and metastasize to regional lymph nodes and lungs (Tsujita and Plummer, 2010). Tsujita and Plummer (2010) quoting Hamir and Parry (1980) and Russell (1956) state that 11% and 1% respectively have metatstatic spread. A further study also states that 61% of animals with enlarged subparotid lymph nodes (LN) had regional LN and lung metastases. In these instances surgery is not indicated due to the extensive spread of the condition within the animal's body (Potter, 2007) and is why in this case surgical excision was chosen.

The use of impression smears and cytology can be a useful aid to diagnosis and future treatment. However, very severe inflammatory reactions can appear very similar to OSCC, hence cytology should only really be used in conjunction with histopathology (Tsujita and Plummer, 2010).

Enucleation is usually performed as described, though xylazine is commonly used as a means of chemical restraint, being particularly useful for fractious patients (Potter, 2007). Xylazine is contra-indicated in the last third of pregnancy as it causes smooth muscle contraction and could result in abortion. I refrained from using it in this case due to the cow being 5 – 6 months in calf. Xylazine can

however be been used if a uterine relaxant such as Planipart is given before surgery (Weaver et al., 2005).

Local anaesthesia for enucleation can be achieved using the retrobulbar block or the Peterson block. A retrobulbar block was used due to familiarity with this method although a number of complications do exist such as intra-orbital haemorrhage, pressure on the globe, accidental rupture of the globe, stimulation of the oculocardiac reflex and inadvertent injection into the optic nerve meninges causing CNS toxicity (Potter, 2007). The Peterson block avoids these complications although the ethmoid turbinates, nasopharynx and maxillary artery may accidentally be entered. The retrobulbar method achieves anaesthesia of the oculomotor, optic, abducent, trigeminal, trochlear and facial. Potter (2007) states that the retrobulbar method achieves greater distribution to target nerves although Edwards (2001) contradicts this stating that the Peterson block is more effective.

Much of the literature appears to contradict one another according to whether the eyelids are anaesthetized following the retrobulbar and Peterson blocks. Tsujita and Plummer (2010) appear to suggest that this will only result in lower eyelid blocking although also state that it may be inadequate. Edwards (2001) states that the Peterson method will block all eye structures except the eyelid, although it is not clear which one. Schulz (2008) suggests both eyelids are blocked by both methods although it may be inadequate. I performed an auriculopalpebral block and ring block of the eye to ensure complete analgesia of the eyelids as it was not obviously clear from the literature what to perform.

The eyelids were sealed prior to surgery to prevent bacterial contamination of the surgical site and care was taken not to enter the conjunctival sac during sharp and blunt dissection for the same reasons (Potter, 2007).

Over cautious haemostasis is unnecessary and packing for a moment as I did is usually sufficient (Weaver et al., 2005). Following removal of the eye a large dead space remains, which is commonly packed with gauze in equine surgery. However, for bovine surgery in a field setting this is impractical, increasing management and handling post-operatively. This option may be indicated if there was a significant amount of post operative haemorrhage. A tight seal should be formed with the skin sutures to prevent blood leakage ensuring a steady build up of pressure creating a tamponade effect

preventing further haemorrhage. A large blot clot will form to occupy the dead space, which will organize resulting in a slightly sunken appearance to the orbit in future (Potter, 2007). Schulz (2008) describes using a “trampoline suture” to reduce the hollowness of the orbit after the procedure. This was performed on this case but to reduce the tension on the skin sutures.

Amoxicillin (Amoxypen LA®, MSD) was used due to its spectrum of activity against gram positive and negative bacteria and the likelihood of a mixed infection in this instance. It was administered pre and post operatively for up to 6 days following the recommendations of Weaver et al. (2011). Intraorbital antibiotic boluses are described as being used, although, this has been associated with abscess formation and is therefore ill advised (Schulz, 2008).

Schulz and Anderson (2010) state that only 17% of cattle in a retrospective study over a period of 8 years up until 2006 were administered NSAIDs. This is very low considering the pain and suffering that OSCC can cause. This case was administered with meloxicam (Metacam®, Boehringer Ingelheim) to ensure that pain was minimized at all times.

Schulz and Anderson (2010) also found in the aforementioned study that 19% of cattle developed orbital infections within 3 weeks of surgery. This is not surprising considering the field conditions under which many of these operations are performed. This case thankfully had no post – operative infection and was completely healed at suture removal 3 weeks after surgery.

11.8.8 Conclusion

Enucleation is a relatively straight forward and inexpensive operation. It represents a successful way to alleviate pain and discomfort and in the majority of cases ensures a cow has time to calve or rear her calf before being culled (Anderson and Schulz, 2010).

11.8.9 References

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11.8.9.1 Appendix 1 – Picture of cow post surgery.



11.9 Appendix 5 – Investigation and Control of Mycobacterium sbsp. Paratuberculosis in a Dairy Herd

ANDREW HENDERSON

ECBHM CASE REPORT 5

11.9.1 Case summary

A colleague visited a dairy client to examine a cow 2 months post calving with profuse diarrhoea and milk drop. Clinical examination led to a provisional diagnosis of Johne's. A blood test was performed confirming the animal was antibody positive. A faecal sample was then taken from the individual for faecal culture of *Mycobacterium avium spp. Paratuberculosis* (MAP), this was also positive (See Appendix 1 & 2).

11.9.2 Background information

11.9.2.1 Herd size, breed, fertility management & production

The herd comprised 191 Holsteins calving all year round. The herd was split into early and late lactation groups. The early lactation group were bred using artificial insemination and the late lactation group bred with a Hereford sweeper bull. Heifer replacements were reared off farm on contract from weaning at 10 weeks of age and then returned 3 weeks pre-calving. Replacements received 2 services with sexed semen and are then bred to a Hereford bull. Total annual milk sales were 1.6 million litres, equating to a 305 day milk yield of 8,024 litres with a 12 month rolling mean of 3.38% protein and 3.87% butterfat. The farm was partially closed with bulls being bought as required.

11.9.2.2 Housing

Lactating cows were housed on deep bedded straw cubicles on concrete bases; the early lactation group also had rubber mats on top of the concrete bases. Dry cows were split into two groups; from dry off to 3 weeks pre-calving ("far off" dry cows) and for the last three weeks ("close up" dry cows). The target dry period length was 60 days. All cows were housed from October to March; but from March to October the late lactation group and far off dry cows were grazed. Freshly calved cows are housed on a loose straw yard for 1 – 2 weeks post calving and are mixed with cows suffering from lameness, unspecified illness and clinical mastitis.

11.9.2.3 Calving management

The close up dry cow group was loosed housed on a straw yard all year round for up to 3 weeks pre-calving. This group may contain up to 25 cows at any one time. The yard is

overstocked having space for only 20 cows (based on 1.25 square meters per 1000 Litres). Cows calve down in this yard and are only moved to the yard for fresh cows after 2 days. The yard is bedded with fresh straw once daily using a straw blower and cleaned out every 4 – 6 weeks. The calves will be put onto the dam's teat if not seen suckling. They are left with their dam for up to 48 hours and then removed. Calves are bucket reared in pairs, having contact with next door pens; they were also fed pooled waste milk.

11.9.3 Immediate action

A meeting was arranged on farm to discuss the disease and the route they wanted to proceed. A range of scenarios were discussed including continuing without further investigation, test and cull, becoming a flying herd, test and cull including improvement of calf management, eradication and vaccination.

The farm wanted to expand to 250 cows and to continue breeding their own replacements. They did not see themselves needing to achieve accredited free status as they were not looking to sell heifers. They did see Johne's as a problem, which could limit their future expansion and profitability, hence they decided to test, selectively cull cows and implement risk based management changes.

11.9.4 Diagnostic testing

11.9.4.1 Dry cows

All dry cows were initially tested (blood antibody) to allow immediate management at calving to be implemented. Results can be seen in Appendix 3 and indicated all tested animals were negative. The Hereford bull was tested along with the dry cows and was also found to be negative.

11.9.4.2 Whole herd

The whole herd was then milked tested using the National Milk Laboratories (NML) Herdwise Scheme. NML is a large diagnostic testing laboratory in the United Kingdom. Its Herdwise Scheme involves quarterly individual milk ELISA testing, which is performed at the same time as monthly milk recording for somatic cell count and yield information. For this

herd it was the easiest method to ensure whole herd testing was performed, it was the least costly and involved no farm labour as a sampling technician was provided.

The Herdwise Scheme provides a key or table to help interpret the use of their results which are provided with each quarterly report; this can be viewed in Table 1

Risk Level	Herdwise Classification	Johne's infection group	Definition
LOW	Green	J0	Repeat ELISA –ve (minimum 2 tests)
	Green	J1	ELISA –ve but only one test
	Green	J2	ELISA –ve but +ve within 3 previous tests
HIGH	Yellow	J3	ELISA –ve/+ve interchangeably
	Yellow	J4	Last ELISA +ve, all previous tests negative
	Red	J5	Repeat ELISA +ve (minimum 2 tests)

Table 1: *A key to interpret NML Herdwise Scheme results: 'Red' cows are those which are likely to be shedding significant quantities of bacteria and are likely to become clinically affected by the disease in the near future. 'Yellow' cows are those which are likely to be shedding the bacteria intermittently (so still pose a risk of spreading the disease) and may well be showing the production effects associated with Johne's disease (high SCC, mastitis, poor yields etc). 'Green' cows are those which have been repeatedly testing negative and considered to be unlikely to be sheding the bacteria and these are deemed low risk* (NMR, 2015).

The whole herd screen identified 155 green or low risk cows, 9 yellow cows and 0 red cows; therefore 9 high risk cows were identified. These high risk individuals are most likely to spread of the disease within the herd and were at risk of a clinical breakdown and should be managed appropriately. This result suggested a possible herd prevalence of 5%, indicating MAP infection within this herd was possibly low at this time. Though, it must be remembered this was a snapshot test of the herd at one point in time using an imperfect test.

11.9.5 Risk assessment

A risk assessment was performed in conjunction with the farmer looking at specific areas of farm management. A systematic review of risk factors for transmission of infection was undertaken according to Nielsen and Nielsen (2007).

A number of risk factors were identified:

11.9.5.1 Calving area

A. Poor hygiene (infrequently cleaned out)
B. Over-stocking
C. All cows calve together in one yard, lack of individual calving pens or segregation facilities
D. Calves remain with dam for nearly 48 hours post birth
E. Calves can suckle other cows

11.9.5.2 Calves prior to weaning

A. Calves are fed pooled waste milk
B. Feeding of milk from sick cows

11.9.5.3 Heifers 6 months to calving

A. Manure/slurry is spread on pasture which may be grazed by this group within the next 12 months

11.9.5.4 Control & long term management

These main risk factors were considered and then control measures were decided upon in discussion with the client to ensure compliance. Control measures were divided into 3 categories to allow the client to easily understand the main areas of importance:

1. Prevention of new infections in calves.
2. Identify infected animals.
3. Breeding and culling policy.

More detailed recommendations were provided in a letter to the client and can be seen in Appendix 4. The main areas which warranted particular focus are summarised below.

11.9.5.5 Prevention of new infections in calves

11.9.5.6 Calving area

1. High risk cows should be calved in the isolation box beside the parlour.
2. Stocking density of calving yard must be reduced using empty yard next door.
3. The calving yard should be cleaned out at minimum every 4 weeks.

4. Low risk cows should calve in individual calving boxes within calving yard.
5. Calving boxes must be cleaned & disinfected between each calving.
6. All calves should be immediately removed from dams; except beef calves which may be removed when practically possible.
7. Colostrum from high risk cows must be discarded.
8. Develop a colostrum bank from the oldest test negative cows.
9. Holstein heifers born to low risk cows should be fed 3 – 4 litres of colostrum from their own mother at removal from dam. The udder and teats should be thoroughly cleaned before collection of colostrum, which should be fed via bottle or stomach tube rather than allowing the calf suckle.

11.9.5.7 Calves prior to weaning

1. Holstein heifers from high risk cows should enter the beef herd or be reared separately and marked as high risk.
2. Holstein heifer calves should be reared on powdered milk replacer.
3. Heifer replacements should be reared separately in individual hutches.

11.9.5.8 Heifers 6 months to calving

1. Holstein heifers should not be grazed on pasture where adults have grazed or where slurry has been spread in the past 3 months, ideally 1 year.

11.9.5.9 Identify infected animals

1. NMR Herdwise testing should be carried out quarterly and we must ensure this is not within 2 months of a previous tuberculin test.
2. High risk cows should be marked with red cable ties on ear tags.

11.9.5.10 Breeding & culling policy

1. High risk cows should only be bred to beef bulls if retained.
2. Heifers from high risk cows should only be bred to beef bulls if retained.
3. High risk cows should be culled at the first sign of clinical disease (usually within 3 months of calving), repeated issues with lameness, fertility, mastitis, gut problems or when yield is low.

These points were fully discussed and it was reinforced that strict adherence must be followed to ensure future control, which may take 10 - 20 years. It was made clear that record keeping on farm had to be accurate. This would allow staff to know a cow's status quickly and manage accordingly.

11.9.6 Economics

The economic consequences of MAP in UK dairy herds can be significant and as with all production diseases costs can be broken down into direct and indirect costs. Direct costs include veterinary costs, herdsman's time, laboratory fees, culls and the costs of implementing management changes to limit the spread and development of new infections within the herd (Esslemont & Kossaibati, 2002). Indirect costs include lost milk production, reduced fertility, sub-optimal culling, reduced cull value and herd value if breeding or pedigree animals are being sold (Groenendaal, 2003).

Groenedaal (2003) found that the greatest proportion of the losses were attributable to sub-optimal culling (69%) with only 9% down to reduction in slaughter value. Though Ott et al. (1999) attribute > 75% of the losses due to Johne' s disease as a result of reduced milk production. It can be difficult to quantify losses within a herd due to Johne's and indirect costs such as lost milk production could be more significant (Gunn, Humphry and Stott, 2004). Reported losses can vary quite widely between studies (Benedictus et al., 1987; Esslemont and Kossaibati, 2002; Gunn et al. 2004) and can even be insignificant when compared to those caused by mastitis, infertility and lameness (Caldow et al., 2004).

The cost of culls on this farm in the first year could be assumed to be £650 (Esslemont and Kossaibati, 2002) as only one case has been identified. However, if a proper costing is done as shown below in Table 2 a quite different figure is produced in 2015.

	Unit	Cost/Unit (£)	Cost (£)
Return from cull cow			794
Lower cull value of clinical Johne's cow			558
Loss from clinical Johne's cow			236
Lower production from sub-clinical cows (12.5% reduction in average milk yield)	952	0.2349	224
Cost of replacement heifer			1200
Lower milk production from heifer	1400	0.2349	329
Lower value of a smaller heifer			8
Total cull losses due to a clinical case of Johne's			1439

Table 2: *Value of cull due to clinical Johne's (Esslemont and Kossaibati, 2002; Farmers Weekly, 2015; Dairy Co., 2015).*

Table 2 presents more realistic figure and with many more animals likely to be sub-clinically infected costs can rapidly spiral out of control (Hayton, 2007). This herd signed up to the NMR Herdwise Scheme, which had an estimated cost of £1329 per year and implementation of biosecurity measures also has associated costs. A Dutch control program has shown the benefits of a full control program outweigh the costs even when labour is included (Groenendaal et al. 2002). In this case I cannot say how likely the herd will be to have a net cost benefit, which is one of the limitations of many endemic disease control programs.

11.9.7 Discussion

The control of MAP is not as clear as many other endemic diseases and there are five main areas, which make its control long and arduous (Caldow et al., 2001). These areas include the long latent phase between infection and development of clinical disease, the lack of sensitivity during the sub-clinical phase of the tests available, the transmission of infection from adults to calves, the ability of MAP to survive in the environment for long periods of time and other reservoirs of the infection (Caldow et al., 2001). The suggested control measures attempted to address these areas.

The long term nature of a MAP control plan was highlighted to the farmer so motivation was not lost along the way and is an important responsibility of all veterinary surgeons when dealing with such a problem (Caldow et al., 2001; Groenendaal et al., 2002). MAP cannot be eradicated using a test and cull control program and it has been demonstrated that this results in a slower increase in herd prevalence, but still an increase (Groenendaal 2003). Hence, this is not economically feasible and testing should only be aimed at motivating clients to change farm management. Changes including calf hygiene practices in conjunction with test and cull are however effective (Caldow et al., 2004; Hayton, 2007; Groenendaal, 2003; Orpin et al., 2005) and this is why we followed a control program focusing on these elements.

Young calves are the most susceptible to infection with up to 80% of new infections occurring within the first month of life (Hayton, 2007; Taylor, 1953). It is thought the ability to absorb immunoglobulins within the first 24 hours of life plays a significant role in this (Hayton, 2007). Improved calf hygiene from day one has been shown to have significant benefits economically and in reducing prevalence of infection long term (Groenendaal et al. 2002). Transmission of MAP occurs primarily in the faeces and therefore, hygiene is extremely important. Many risk factors related to management have been highlighted including inadequate straw bedding and manure build up in calving areas (Bergahaus et al., 2005; Johnson-Ifearulundu and Kaneene, 1998) and is why hygiene and management around calving was a particular focus in the recommendations.

MAP can also be shed in colostrum and milk and therefore recommendations were made to improve colostrum management (Sweeney et al. 1992). The use of milk powder feeding for

replacement heifers was implemented as they were currently being fed pooled waste milk. This is inappropriate due the presence of antibiotic residues and bacteria and could be linked to future risk of being ELISA positive (Nielsen and Toft, 2008). Segregation practices may also help prevent cross – suckling which could be another avenue for the development of new infections. Calves were removed immediately at birth as it has been shown that removing the calf from the dam within an hour of birth significantly reduces the likelihood of herd infection relative to herds who allow calves to remain with their dams for 12 hours (Goodger et al., 1996); currently calves were remaining for up to 48 hours.

MAP transmission is also known to occur across the placenta with heifers born to MAP positive cows having a 0 – 50% probability of infection dependent on whether the dams are latently or clinically infected (Groenendaal, 2003; Whittington and Windsor, 2007). Therefore, it was suggested calves born to high risk dams should not join the herd.

The farm purchased individual hutches for all heifer calves in part due to the recommendations for MAP control but also to attempt control for neonatal diarrhoea and respiratory disease, which were a problem on this farm. Rearing individually is important as there has been a suggested association between herd infection with MAP and housing calves communally (Collins et al., 1994). These were sited away from the cows to ensure slurry was completely separated and not a source of infection.

MAP has been shown to have the ability to survive in the environment for long periods. Hayton (2007) quoting Sweeney (1996) states that MAP can survive for up to a year in water and slurry and quoting Caldow et al. (2001) up to 47 months in soil. Its resistant to environmental degradation is due to its waxy cell wall although the significance of this as a source of infection in unknown (Caldow et al., 2001; Jones, 2001). Due to this environmental persistence it is important to ensure excellent grazing management to avoid young-stock less than 12 months of age being grazed on areas where adults or slurry have been or been spread within the last 12 months.

A reservoir of MAP infection has been demonstrated in other ruminant species and non ruminant species such as stoats, rooks, foxes, badgers and rabbits. It has been shown that experimental infection of calves with MAP from rabbits showing typical lesions caused infection in calves. The role of wildlife in the epidemiology is not fully understood and it is

not known if they are reservoir of true infection or a spill over from domestic ruminants and large amounts of environmental contamination (Jones, 2001; Caldow et al., 2001; Hayton, 2007). However, this is of much lower importance in a control program and almost impossible to control in a herd which grazes in the spring and summer.

Once ingested, MAP enters macrophages within the Peyer's patches, stimulating inflammatory mediators and the development of inflammatory lesions in the intestinal mucosa and regional lymph nodes. Over years the cell mediated immunity wanes allowing proliferation and shedding of MAP and stimulation of a humoral immune response and production of antibodies. It is at this point that detection of an infected animal is possible by ELISA, but this is already at a late stage of infection. The development of the humoral response is strongly correlated with the degree of faecal shedding (Hayton, 2007). Not all individuals follow this and some can be intermittently bacteraemic, shedding very early in the course of the disease even when it is undetectable (Caldow et al., 2001; Caldow et al., 2004; Jones, 2001; Hayton, 2007).

A herd based testing program was decided upon only once the initial blood ELISA had been confirmed by an organism based test i.e. culture. A scheme using the milk ELISA was chosen and the milk and serum ELISA is quoted by Nielsen and Toft (2009) as having a sensitivity of 11% and specificity of 98%. This varies significantly from the reported sensitivity of 45% (Sweeney et al., 1995). Orpin (2005) quoting Reichel et al. (1999) states the sensitivity of the ELISA to be 47%; this is when compared to faecal culture; the gold standard. Faecal culture is stated to have a sensitivity of 33%, 45% and 50% in different papers (Caldow et al., 2004; Caldow et al., 2007; Hayton, 2007). Variation may be expected between test kits, though on balance sensitivity may be assumed to be around 25%. As a result this is why the herd was tested four times per year to increase the possibility of identification of infected animals.

Prevalence of a herd cannot be easily determined due to the poor sensitivity of the ELISA and the latency of infection. However, estimation of the true prevalence of disease with confidence limits can be made with an imperfect test using statistical sample size calculators (AusVet, 2015). In any Johne's herd management scheme certain principles should be followed such as implementation of heifer rearing practices, interpreting ELISA results quantitatively and acting based on the magnitude of results and repetition (Collins, 2011).

Due to the specificity of the ELISA, once a cow was repeatedly identified as 'Red', it was assumed positive and no further confirmatory tests were used. However, it must be remembered that false positives do occur and the positive predictive value of the test will vary according to the herd prevalence. Therefore, in herds with an estimated low prevalence serial testing should be considered prior to making culling decisions.

Vaccination is another option to use in the control of MAP and can greatly reduce the losses caused by MAP and is on average economically attractive to dairy farms (Groenendaal, 2003). The incidence of clinical disease may be reduced or onset delayed, though prevalence and subclinical losses will not (Groenendaal, 2003). It was decided against this approach due to its limitations, the apparent low prevalence within the herd and willingness of the famer to implement management changes.

11.9.8 Conclusion

This control program highlights the difficulties faced when implementing a MAP control program. It should also be noted that implementation of these measures on farm will ultimately improve the control of many other health issues.

11.9.9 References

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Appendix 1 – First case conformation by ELISA

[redacted]

Serology / Virology

Animal ID	Johnes Ab ELISA sample OD	Johnes Ab ELISA cut off OD	Johnes Ab ELISA result
COW 80	1.616	0.281	**POSITIVE**

JOHNE'S

Johnes Ab ELISA

Result	*Comment*
Positive ELISA	Johne's disease is very likely. However, false-positive results are rare but possible. If this is the first case in a herd and control is likely to be considered, it may be useful to establish the presence of *MAP* by PCR or culture of a sample of faeces or by a post mortem examination.

Dom

[redacted]

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Appendix 2 – Confirmation by faecal culture



Laboratory Findings

PCR / Liquid Culture Results

Animal ID	Culture Result	Comment
UK342858 400825.	POSITIVE	Culture detected acid-alcohol fast bacilli morphologically typical of *Mycobacterium avium paratuberculosis*

CHARGE AMENDMENT:
Please note that the charge has been amended to reflect the test requested. The charge for all work carried out will be as shown on this report. Please ignore the charge shown on Report 1 (dated 28/01/2010) which has been cancelled.

T W H Jones

T·W H Jones MRCVS
Veterinary Investigation Officer
01/04/2010

Booked SM

Amended Charges: The amended charge for this laboratory work is £37.00 plus VAT if applicable. This will be included in your monthly statement.
Service Charge Code(s): TC0713 x 1

INVESTORS IN PEOPLE

‡ - Test subcontracted; opinions given and interpretations of the result are outside the scope of UKAS accreditation.
† - Not UKAS accredited; opinions given and interpretations of the result are outside the scope of UKAS accreditation.
For further details of the test methods used, and other terms and conditions, please refer to the VLA Website.

Appendix 3 – Initial screen of dry cows



Report 1 (Final)

Serology

	Sample Id.	Johne's Ab ELISA sample OD	Johne's Ab ELISA cut off OD	Johne's Ab ELISA result
1	6	0.072	0.182	Negative
2	15	0.054	0.182	Negative
3	20	0.071	0.200	Negative
4	28	0.061	0.182	Negative
5	35	0.077	0.182	Negative
6	36	0.058	0.182	Negative
7	48	0.074	0.182	Negative
8	50	0.066	0.200	Negative
9	54	0.061	0.200	Negative
10	111	0.065	0.182	Negative
11	344	0.073	0.182	Negative
12	363	0.074	0.200	Negative
13	383	0.100	0.182	Negative
14	401	0.064	0.200	Negative
15	498	0.091	0.200	Negative
16	658	0.064	0.200	Negative
17	709	0.070	0.182	Negative
18	751	0.066	0.182	Negative
19	756	0.084	0.182	Negative
20	775	0.068	0.182	Negative
21	786	0.062	0.182	Negative
22	865	0.068	0.200	Negative
23	960	0.065	0.200	Negative

OI

The charge for this laboratory work is £116.80 plus VAT if applicable. This will be included in your monthly statement.
Service Charge Code(s): TC0366 x 27 Booked SM

INVESTORS IN PEOPLE

‡ - Test subcontracted; opinions given and interpretations of the result are outside the scope of UKAS accreditation.
† - Not UKAS accredited; opinions given and interpretations of the result are outside the scope of UKAS accreditation.
For further details of the test methods used, and other terms and conditions, please refer to the VLA Website.

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	Sample Id.	Johne's Ab ELISA sample OD	Johne's Ab ELISA cut off OD	Johne's Ab ELISA result
24	966	0.072	0.200	Negative
25	971	0.063	0.182	Negative
26	1027	0.069	0.200	Negative
27	501112	0.058	0.182	Negative

Johne's Ab ELISA interpretation:

Result	Comment
Negative ELISA.	This animal is not likely to have Johne's disease. The ELISA test is most sensitive in animals with severe clinical signs of long duration. It may therefore be advisable to resample this animal in 6-8 weeks time. Examination of a sample of faeces by PCR or culture could also be used to determine infection status.

It should also be noted that the ELISA result may be influenced by intradermal tuberculin testing. The duration and magnitude of this effect is not known absolutely but it may need to be considered especially if animals give unexpected, positive ELISA results within a month or so of a TT test.

T W H Jones MRCVS
Veterinary Investigation Officer
10/02/2010

Appendix 4 – Farm Control Points

[redacted]

FARM JOHNES MANAGEMENT PLAN

1. PREVENT NEW INFECTIONS IN CALVES

- All calves on farm must be separated from adults; meaning adults should never pass close to calf rearing areas to prevent faecal contamination of calf areas.
- Faecal contamination of feed or feeding instruments must be avoided and separate instruments ideally used for calf feeding.
- Faecal contamination of water supplies must be avoided to prevent infection.
- Johnes +ve individuals should be calved beside the parlour.
- Johnes –ve individuals in individual calving boxes in new calving shed.
- Calves should be born in a clean dry environment and calving boxes should be cleaned out & disinfected between cows.
- Develop a colostrum bank from the oldest test negative cows. This is the safest form of colostrum. Be careful not to overheat colostrums when thawing as this destroys the antibodies.
- Johnes –ve cows - Hol Fr Heifer calves should be removed at birth and then stomach tubed or bottle fed 3 – 4 litres of colostrums from their own mother. The udder and teats should be thoroughly cleaned before collection of colostrums. If there is no maternal colostrums, use the stored colostrums from oldest test negative cows. Beef calves should be removed as soon as practically possible.
- Johnes +ve cows – Hol Fr Heifer calves should be removed at birth and not fed milk or colostrum from their mothers. These calves should receive 3 – 4 litres of stored colostrums by bottle or stomach tube. Beef calves should be removed as soon as practically possible. Milk from these cows should not be fed to any calves.

[redacted]

- There are also risks associated with calf rearing off farm and heifers being mixed with animals from other herds. The potential for infection with Johnes is low but exists.
- Always remember that test negative individuals may turn positive.
- Strict adherence to the above points should enable you to control and eradicate Johnes within 10 years.

We will discuss these points at the next routine.

Regards,



11.10 Appendix 6 - Summary of Year 1 – 3 for ECBHM Residency

Resident: Andrew Henderson	Institution: University of Nottingham	
Primary Supervisor: Jon Huxley	Date: 23/02/2016	Year Of Residency: One - Three

Training Element	Numbers
Individual clinical cases	419
Herd health cases	222
Ancillary topics - Pathology/Necropsies	30
Conferences, congresses and professional meetings attended	13
Presentations at conferences, congresses and professional meetings	6
Lectures and seminars attended	61
Lectures and seminars given	43

Date:	23/02/2016
Signature (Resident):	
Date:	23/02/2016
Signature (Supervisor):	

11.11 Appendix 7 – Case Logs Year 1 - 3

11.11.1 Year One ECBHM Residency Case Log

Annual Progress Report Submission Form

Individual Clinical Case Log (Sheet A)

Resident: Andrew Henderson

Date: 27/11/2014

Institution: University of Nottingham

Primary Supervisor: Jon Huxley

Year of Residency: One

Date	Patient ID	Patient Category (species, type, sex, age)	Diagnosis	Clinical activity of the resident	Super vision
02/01/2013	Cow × 1	HF - dairy cow, 3rd lactation	Per-parturient hypocalcaemia	Clinical examination & Treatment	1
03/01/2013	Cow × 1	HF - dairy cow, 5rd lactation	Recumbent Cow with dead calf pre-calving	Clinical examination & salvage caesarean section/euthanasia	1
04/01/2013	Cow × 1	Simmental - beef cow, 4th lactation	Dystocia - head back	Obstetrics	1
07/04/2013	Cow × 1	HF - dairy cow, 2nd lactation	Clinical ketosis and enteritis	Clinical examination & Treatment	1
07/04/2013	Cow × 1	HF - dairy cow, 3rd lactation	Clinical ketosis and retained foetal membranes	Clinical examination & Treatment	1

07/04/2013	Cow × 1	HF - dairy cow, 3rd lactation	Left displaced abomasum	Clinical examination & surgical correction (right sided laparotomy & pyloropexy)	1
31/12/2013	Steer × 2	AAX - beef steer, 15 months	Pneumonia	Clinical examination & Treatment	1
31/12/2013	Heifer × 2	Simmental - beef heifer, 1st calver	Retained foetal membrane	Clinical examination, removal & treatment	1
04/01/2014	Cow × 1	HF - dairy cow, 4th lactation	Clinical Mastitis	Clinical examination & Treatment	1
06/01/2014	Cow × 1	HF - dairy heifer, 1st calver	Caesarean section	Surgery	1
06/01/2014	Cow × 1	HF - dairy cow	Puerperal metritis	Clinical examination & Treatment	1
06/01/2014	Cow × 1	HF - dairy cow, 3rd lactation	Puerperal metritis	Clinical examination & Treatment	1
06/01/2014	Cow × 1	HF - dairy cow, 4th lactation	Right displaced abomasum - dilatation	Clinical examination & medical treatment	1
07/01/2014	Cow × 1	HF - dairy heifer, 1st lactation	Left displaced abomasum & puerperal metritis	Clinical examination & Treatment (surgery - right flank pyloropexy)	1
07/01/2014	Calf × 1	HF - dairy heifer, 2 months	Pneumonia	Clinical examination & Treatment	1
09/01/2014	Cow × 1	HF - dairy cow, 3rd lactation	Left displaced abomasum & puerperal metritis	Clinical examination & Treatment (surgery - right flank pyloropexy)	1
10/01/2014	Calf × 4	Dairy	Blood Sample (Total Protein) - Assessment of Passive Transfer	Internal Medicine	1

10/01/2014	Cow × 1	HF - dairy cow, 5th lactation	Teat Surgery - slash teat to release purulent material from infected quarter	Clinical examination & Treatment (surgery)	1
13/01/2014	Calf × 1	Beef bull calf, 3 months	Lameness - damaged stifle joint	Clinical examination & Treatment with NSAIDs	1
13/01/2014	Calf × 1	Beef heifer calf, 3 months	Silage Eye - listerial uveitis	iry	1
14/01/2014	Cow × 1	HF - dairy cow, 4th lactation	Deep Digital Sepsis - Digit Amputation	Surgical removal of digit	2
14/01/2014	Cow × 1	HF - dairy cow, 6th lactation	Lameness - Wall ulcer	Clinical examination & Treatment (Block & NSAIDs)	1
14/01/2014	Cow × 1	HF - dairy heifer, 1st lactation	Pneumonia	Clinical examination & Treatment	1
14/01/2014	Cow × 1	HF - dairy cow, 5th lactation	Teat Surgery - large growth on teat	Surgery removal under sedation	1
15/01/2014	Cow × 1	HF - dairy cow, 3rd lactation	Cyst right ovary - luteal	Clinical examination & Treatment (prostaglandin)	1
15/01/2014	Calf × 1	HF - dairy bull calf, 4 months	Enteritis/Pneumonia	Clinical examination & Treatment	1
15/01/2014	Cow × 1	HF - dairy heifer, 1st lactation	Retained foetal membrane	Clinical examination, removal & treatment	1
16/01/2014	Cow × 1	HF - dairy cow, 7th lactation	Deep Digital Sepsis - Digit Amputation	Surgical removal of digit	2
16/01/2014	Calf × 1	BBX - beef heifer calf, 2 weeks	Naveil ill/omphalophlebitis	Clinical examination & Treatment	1
16/01/2014	Cow × 1	HF - dairy cow, 3rd lactation	Peritonitis post caesarean section	Clinical examination & Treatment	1

17/01/2014	Calf × 3	HF - dairy heifer calves, < 1 week old	Blood Sample (Total Protein) - Assessment of Passive Transfer	Internal Medicine	1
17/01/2014	Calf × 1	HF - dairy heifer calf, 4 months	Lameness - Foul (interdigital necrobacillosis)	Clinical examination & Treatment	1
17/01/2014	Cow × 1	Fr - dairy cow, 2nd lactation	Puerperal metritis	Clinical examination & Treatment	1
20/01/2014	Cow × 1	HF - dairy cow, 7th lactation	Bandage change - Digit amputation	Wound management	1
20/01/2014	Calf × 1	HF - dairy heifer calf, 2 weeks	Intravenous Fluid Therapy - calf with enteritis	Internal Medicine	1
20/01/2014	Cow × 1	HF - dairy cow, 4th lactation	Lameness - Sole ulcer & White line abscess	Clincial examination & Treatment (Trim, block & NSAIDS)	1
20/01/2014	Cow × 1	HF - dairy cow, 3rd lactation	Peritonitis post caesarean section	Clinical examination & Treatment	1
21/01/2014	Heifers × 21	BBX - beef heifer calf, 14 - 18 months	Pregnancy Diagnosis	Pregnancy Diagnosis	1
21/01/2014	Cow × 1	AAX - beef cow, 8th lactation	Pregnancy Diagnosis	Pregnancy Diagnosis	1
21/01/2014	Cow × 1	HF - dairy cow, 4th lactation	Puerperal metritis	Clinical examination & Treatment	1
22/01/2014	Cow × 1	Longhorn - Beef cow, 3rd lactation	Intussuception	Clinical examination, surgical treatment & euthanasia	2
23/01/2014	Cow × 1	HF - dairy cow, 2nd lactation	Toxaemic metritis	Clincial examination & Treatment	1
23/01/2014	Heifer × 1	HF - dairy heifer, 1st lactation	Toxic mastitis	Clincial examination & Treatment	1

24/01/2014	Cow × 1	HF - dairy cow	Puerperal metritis	Clincial examination & Treatment	1
24/01/2014	Cow × 1	HF - dairy cow, 3rd lactation	Right displaced abomasum with volvulus & Pneumonia	Clinical examination & surgical treatment (gastrotomy & de - rotation)	2
25/01/2014	Heifer/ Steers × 15	Limousin X - beef steer/heifers, 6 months old	Pneumonia	Clinical exmaination, treatment & discussion of management /prevention	1
25/01/2014	Heifer × 1	BBX - beef heifer, 18 months old	Tympanic intestinal colic	Clinical examination & medical treatment	1
26/01/2014	Heifer × 1	HF - dairy heifer, 1st lactation	Bleeding post calving - clotted blood present & metritis	Clinical examination & Treatment	1
26/01/2014	Steer × 1	AA - beef steer, 15 months old	Fractured femur	Clinical examination & euthanasia	1
26/01/2014	Cow × 1	HF - dairy cow, 4th lactation	Periparturient hypocalcaemia	Clinical examination & Treatment	1
27/01/2014	Bull × 1	Simmental - beef bull, 3 years old	Lameness - White Line Disease & Foul	Clinical examination & Treatment	1
27/01/2014	Cow × 1	HF - dairy cow, 3rd lactation	Nervous Ketosis	Clinical examination & Treatment	1
27/01/2014	Calf × 1	Simmental - beef heifer, 2 weeks	Pneumonia	Clinical examination & Treatment	1
27/01/2014	Heifer × 8	Simmental - beef heifers, 18 months	Pregnancy Diagnosis	Pregnancy Diagnosis	1
28/01/2014	Calf × 1	AAX - beef bull calf, 6 months	Castrate	Surgery	1
28/01/2014	Calf × 2	AAX - beef steers, 10 months	Dehorn	Surgery	1

28/01/2014	Calf × 4	HF - dairy bull calf, 3 weeks	Pneumonia	Clinical examination & Treatment	1
28/01/2014	Calf × 2	Simmental X - beef heifers, 2 weeks	Pneumonia & Joint Ill	Clinical examination & Treatment	1
29/01/2014	Calf × 1	Limousin X - beef steer, 2 months old	Gassy bloat, pneumonia & vagal indigestion	Clinical examination & Treatment	1
29/01/2014	Cow × 1	HF - dairy heifers, 1st lactation	Retained foetal membrane/Toxic metritis	Clinical examination & Treatment	1
30/01/2014	Cow × 1	Fr - dairy cow, 3rd lactation	Lame - Sole ulcer	Clinical examination & Treatment (Trim, block & NSAIDs)	1
31/01/2014	Cow × 1	Fr - dairy cow, 2nd lactation	Puerperal metritis	Clinical examination & Treatment	1
03/02/2014	Heifer × 1	HF - dairy heifer, 15 months	Dehorn	Clinical examination & Treatment	1
03/02/2014	Cow × 1	HF - dairy cow, 3rd lactation	Enteritis - digestive upset (mouldy feeds)	Clinical examination & Treatment	1
03/02/2014	Heifer × 1	HF - dairy heifer, 1st lacatation	Infected Front Left Leg - carpal and tendon sheath	Clinical examination & Medical Treatment	1
03/02/2014	Cow × 1	HF - dairy cow, 3rd lactation	Toxic E. coli Mastitis & Intravenous Fluid Therapy	Clinical examination & Treatment	1
03/02/2014	Heifer × 1	HF - dairy heifer, 1st lactation	Traumatic Reticulo-Peritonitis	Clinical examination & Medical Treatment	1
05/02/2014	Cow × 1	HF - dairy cow, 4th lactation	Deep Digital Sepsis - Digit Amputation	Clinical examination & surgical removal	2
05/02/2014	Cows × 60	Limousin - beef cows	Pregnancy Diagnosis	Pregnancy Diagnosis	1

05/02/2014	Cow × 2	HF - dairy cow, 2 & 3rd lactation	Toxic E. coli Mastitis	Clinical examination & Treatment	1
07/02/2014	Cow × 1	BBX - beef heifer, 1st calving	Caesarean section	Obstetric Surgery	1
07/02/2014	Cow × 1	HF - dairy heifer, 1st calving	Dystocia - dead calf relative foetal oversize	Obstetrics	1
07/02/2014	Cow × 1	HF - dairy cow, 3rd lactation	Right displaced abomasum with volvulus	Clinical examination & surgical treatment (gastrotomy & de - rotation)	2
10/02/2014	Cow × 1	HF - dairy cow, 4th lactation	Bandage change - Digit amputation	Wound management	1
12/02/2014	Cow × 1	Charolais X - beef cow, 3rd lactation	Lumpy jaw	Clinical examination & Treatment	1
12/02/2014	Cows × 60	Limousin - beef cows	Pregnancy Diagnosis	Pregnancy Diagnosis	1
13/02/2014	Cow × 1	HF - dairy cow, 5th lactation	Right sided heart failure/Pulmonary hypertension /Pulmonary thromboembolism	Clinical examination & advised cull	2
17/02/2014	Cow × 1	HF - dairy cow, 4th lactation	Downer cow	Clinical examination & Treatment	1
17/02/2014	Cow × 1	HF - dairy cow, 2nd lactation	Left displaced abomasum	Clinical examination & surgical correction (right sided laparotomy & pyloropexy)	1
17/02/2014	Cow × 1	HF - dairy cow, 5th lactation	Puerperal metritis	Clinical examination & Treatment	1
18/02/2014	Cow × 1	British White - beef heifer, 1st calving	Caesarean section	Obstetric Surgery	1
18/02/2014	Cow × 1	HF - dairy cow, 1st lactation	Downer cow - bilateral obturator	Clinical examination	1

			nerve paralysis & dislocated stifle	& emergency slaughter	
18/02/2014	Cow × 2	HF - dairy cow, 2nd & 3rd lactation	Left displaced abomasum	Roll & Toggle (Grymer - Sterner correction)	1
19/02/2014	Cow × 1	HF - dairy cow, 4th lactation	Left displaced abomasum	Clinical examination & surgical correction (right sided laparotomy & pyloropexy)	1
22/02/2014	Cow × 1	HF - dairy heifer, 1st lactation	Enteritis	Clinical examination	1
22/02/2014	Cow × 1	Limousin - beef cow, 6th lactation	Uterine Prolapse	Clinical examination & replacement	1
23/02/2014	Cow × 1	Hereford - beef heifer, 1st calving	Breech calving	Clinical examination & correction	1
23/02/2014	Cow × 1	Jersey - dairy cow, 2nd lactation	Subcutaneous emphysema (clostidial disease ?)	Clinical examination & euthanasia	1
23/02/2014	Cow × 1	Fr - dairy cow, 7th lactation	Uterine Prolapse	Clinical examination & replacement	1
24/02/2014	Cow × 1	HF - dairy cow, 3rd lactation	Clinical Ketosis	Clinical examination & Treatment	1
25/02/2014	Bull × 2	Devon Red - 2 year & 5 year old	Fertility assessment	Bull breeding soundness examination - testicular hypoplasia & pass	1
26/02/2014	Calf × 1	Simmental X - beef steer, 6 months	Cerebrocortical malacia	Clinical examination & Treatment	1
03/03/2014	Cow × 1	HF - dairy cow, 5th lactation	Cow with right displaced abomasum & volvulus (severely	Clinical examination & euthanasia	1

			toxaemic & recumbent)		
03/03 /2014	Cow × 1	HF - dairy cow, 3rd lactation	Cow with subclinical ketosis	Clinical examination & Treatment	1
04/03 /2014	Cow × 1	Fr - dairy cow, 4th lacatation	Clinical ketosis	Clinical examination & Treatment	1
04/03 /2014	Cow × 1	Limousin - beef cow, 3rd lactation	Vaginal prolapse	Clinical examination & Treatment	1
05/03 /2014	Cow × 1	HF - dairy cow, 2nd lactation	Dislocated hip left leg	Clinical examination & emergency slaughter	1
05/03 /2014	Cow × 1	HF - dairy heifer, 1st lactation	Heifer with chronic pneumonia	Clinical examination, ultrasound sacn of lung fields & treatment	1
05/03 /2014	Cow × 1	HF - dairy cow, 6th lactation	Left displaced abomasum	Clinical examination & surgical correction (right sided laparotomy & pyloropexy)	1
06/03 /2014	Cow × 1	HF - dairy cow, 3th lactation	Left displaced abomasum	Clinical examination & surgical correction (right sided laparotomy & pyloropexy)	1
07/03 /2014	Cow × 1	HF - dairy heifer, 1st lactation	Retained foetal membranes	Clinical examination & Treatment	1
10/03 /2014	Cow × 1	HF - dairy cow, 6th lactation	Cow with subclinical ketosis	Clinical examination & Treatment	1
13/03 /2014	Cow × 1	HF - dairy cow, 2nd lactation	Calving/milk fever/pneum onia	Clinical examination & Treatment	1
13/03 /2014	Cow × 1	HF - dairy cow, 8th lactation	Dislocated hip left leg	Clinical examination & emergency slaughter	1
13/03 /2014	Cow × 1	HF - dairy cow, 5th lactation	Milk Fever	Clinical examination & Treatment	1

14/03/2014	Cow × 1	HF - dairy cow, 4th lactation	Dislocated hip right leg	Clinical examination & emergency slaughter	1
14/03/2014	Cow × 1	HF - dairy cow, 2nd lactation	Left displaced abomasum	Clinical examination & surgical correction (right sided laparotomy & pyloropexy)	1
14/03/2014	Calf × 1	HF - dairy heifer, 2 weeks	Pneumonia	Clinical examination & Treatment	1
17/03/2014	Cow × 1	HF - dairy cow, 3rd lactation	Left displaced abomasum	Clinical examination & surgical correction (right sided laparotomy & pyloropexy)	1
17/03/2014	Cow × 1	HF - dairy cow, 5th lactation	Tympanic intestinal colic	Clinical examination & medical treatment	1
18/03/2014	Calf × 5	Simmental X - beef calves, 3 months	Dehorn & castrate	Dehorn & surgical castrate	1
19/03/2014	Cow × 1	Belgian Blue X - beef cow, 3rd parity	Choke - oesophageal obstruction	Clinical examination & medical treatment	1
19/03/2014	Calf × 4	Aberdeen Angus X - beef calves, 2 months	Dehorn	Dehorn	1
21/03/2014	Cow × 4	Longhorn - Beef cow, 1st parity	Inspect for synchronisation program	Rectal palpation/ultrasound and insert CIDRs	1
21/03/2014	Calf × 1	Limousin X - beef calf, 1 week	Pneumonia	Clinical examination & Treatment	1
02/04/2014	Cow × 1	HF - dairy cow, 3rd lactation	Left displaced abomasum	Clinical examination & surgical correction (right sided laparotomy & pyloropexy)	1
07/04/2014	Cow × 1	HF - dairy cow, 4th lactation	Stomach ulcer & peritonitis	Clinical examination	1

				& advised euthansia	
08/04 /2014	Cow × 2	HF - dairy cow, 3rd & 4th lactation	Left displaced abomasum	Clinical examination & surgical correction (right sided laparotomy & pyloropexy)	1
09/04 /2014	Cow × 1	HF - dairy cow, 2nd lactation	Tibial nerve paralysis	Clinical examination & Treatment	1
09/04 /2014	Cow × 1	HF - dairy cow, 6th lactation	Toxaemia of unknown origin	Clinical examination & advised euthansia	1
09/04 /2014	Heifer × 1	Belgian Blue - 1st calving	Caesarean section	Obstetric Surgery	1
11/04 /2014	Heifer × 1	Longhorn - beef heifer, 13 months	Damaged horn	Remove	1
11/04 /2014	Steer × 1	Longhorn - beef steer, 15 months	Abscess on flank	Clinical examination, lance and flush	1
12/04 /2014	Cow × 1	HF - dairy cow, 3rd lactation	Calving	Delivery	1
12/04 /2014	Cow × 1	HF - dairy cow, 4th lactation	Milk Fever	Clinical examination & Treatment	1
12/04 /2014	Cow × 1	HF - dairy heifer, 1st lactation	Traumatic Reticulo-Peritonitis	Clinical examination & medical treatment	1
13/04 /2014	Cow × 1	HF - dairy cow, 4th lactation	Caesarean section	Obstetric Surgery	1
13/04 /2014	Steer × 1	Aberdeen Angus	Compound fracture of tibia and fibia	Clinical examination & emergency slaughter	1
13/04 /2014	Cow × 1	Belgian blue X - beef cow, 7th parity	Lateral recumbency & bloat	Clinical examination & Treatment	1
13/04 /2014	Cow × 1	Simmental - beef heifer, 1st calving	Toxaemic metritis & retained foetal membranes	Clinical examination & Treatment	1
15/04 /2014	Cow × 2	HF - dairy cows, 3rd lactation	Left displaced abomasum	Clinical examination & surgical	1

				correction (right sided laparotomy & pyloropexy)	
15/04 /2014	Cow × 1	Jersey - dairy cow, 2nd lactation	Left displaced abomasum	Clinical examination & surgical correction (right sided laparotomy & pyloropexy)	1
15/04 /2014	Calf × 1	HF - dairy heifer, 2 weeks	Patent urachus	Clinical examination, ultrasound scan and euthanasia	1
16/04 /2014	Cow × 1	Simmental - beef cow, 8th parity	Down cow - obturator nerve paralysis and hypomagnaes aemia	Clinical examination & Treatment	1
17/04 /2014	Cow × 1	HF - dairy cow, 3rd lactation	Metritis	Clinical examination & Treatment	1
17/04 /2014	Cow × 1	HF - dairy cow, 2nd lactation	Metritis	Clinical examination & Treatment	1
18/04 /2014	Cow × 1	HF - dairy cow, 5th lactation	Milk Fever	Clinical examination & Treatment	1
18/04 /2014	Cow × 1	HF - dairy cow, 2nd lactation	Toxic mastitis	Clinical examination & Treatment	1
22/04 /2014	Cow × 1	Saler - beef cow, 3rd parity	Silage Eye - listerial uveitis	Clinical examination & Treatment	1
23/04 /2014	Cow × 1	Belgian Blue - beef cow, 4th parity	Calving	Delivery	1
23/04 /2014	Bull × 2	Limousin X - beef calf 3 months	Castration	Surgical castration	1
23/04 /2014	Cow × 1	Belgian Blue - beef cow, 2nd parity	Dehiscence of laparotomy wound	Debride, clean/flush	1
23/04 /2014	Heifer × 1	HF -dairy heifer, 1st lactation	Metritis	Clinical examination & Treatment	1
23/04 /2014	Cow × 1	HF - dairy cow, 3rd lactation	Metritis	Clinical examination & Treatment	1

23/04/2014	Cow × 1	HF - dairy cow, 2nd lactation	Metritis	Clinical examination & Treatment	1
23/04/2014	Heifer × 1	HF -dairy heifer, 1st lactation	Pneumonia	Clinical examination & Treatment	1
23/04/2014	Heifer × 1	HF -dairy heifer, 1st lactation	Pneumonia	Clinical examination & Treatment	1
24/04/2014	Cow × 1	HF - dairy cow, 3rd lactation	Left displaced abomasum	Clinical examination & surgical correction (left sided laparotomy & abomasopexy)	1
24/04/2014	Cow × 1	Friesian - dairy heifer, 1st lactation	Sole ulcer	Clinical examination & Treatment (Trim, block & NSAIDs)	1
25/04/2014	Cow × 1	Saler - beef cow, 3rd parity	Silage Eye - listerial uveitis	Clinical examination & Treatment	1
25/04/2014	Cow × 1	Saler - beef cow, 5th parity	Silage Eye - listerial uveitis	Clinical examination & Treatment	1
12/05/2014	Cow × 1	HF - dairy cow, 2nd lactation	Left displaced abomasum	Clinical examination & surgical correction (right sided laparotomy & pyloropexy)	1
12/05/2014	Cow × 1	HF - dairy cow, 4th lactation	Retained foetal membranes	Clinical examination & Treatment	1
04/08/2014	Calves × 6	HF - dairy heifers, 4 weeks	Coccidiosis	Clinical examination & Treatment	1
05/08/2014	Cow × 1	HF - dairy heifer, 1st lactation	Pneumonia	Clinical examination & Treatment	1
07/08/2014	Cow × 1	Jersey - dairy cow, 1st lactation	Caesarean section	Obstetric Surgery	1
07/08/2014	Cow × 1	HF - dairy cow, 3rd lactation	Deep Digital Sepsis - Digit Amputation	Clinical examination & surgical removal	1

08/08/2014	Cow × 1	HF - dairy heifer, 1st lactation	Metritis	Clinical examination & Treatment	1
12/08/2014	Cow × 1	HF - dairy cow, 3rd lactation	Deep Digital Sepsis - Digit Amputation	Clinical examination & surgical removal	1
12/08/2014	Cow × 1	Simmental - beef cow, 4th parity	Johne's	Clinical examination, diagnosis (blood test) & advised euthanasia	1
12/08/2014	Cow × 1	Simmental - beef steer, 4 months	Pneumonia & omphalophlebitis	Clinical examination & Treatment	1
13/08/2014	Cow × 1	HF - dairy cow, 3rd lactation	Calving	Delivery	1
13/08/2014	Bull × 1	Holstein - dairy bull, 3 years	White line abscess	Sedation, clinical examination, trim and rest	1
15/08/2014	Cow × 1	HF - dairy cow, 3rd lactation	Bandage change - Digit amputation	Wound management	1
31/08/2014	Cow × 1	HF - dairy cow, 2nd lactation	Calving - dead twins	Delivery	1
31/08/2014	Cow × 1	Friesian - dairy heifer, 1st lactation	Calving - head back	Delivery	1
31/08/2014	Cow × 1	HF - dairy heifer, 1st lactation	Calving - head back	Delivery	1
01/09/2014	Cow × 1	Simmental X - beef cow, 5th parity	Wooden tongue	Clinical examination & Treatment	1
02/09/2014	Cow × 1	HF - dairy cow, 3rd lactation	Calving - dead calf	Delivery	1
02/09/2014	Calf × 1	HF - dairy heifer, 2 months	Naveil ill/omphalophlebitis	Clinical examination & Treatment	1
02/09/2014	Cow × 1	HF - dairy heifer, 1st lactation	Severe fatty liver & clinical ketosis	Clinical examination & Treatment	1
03/09/2014	Calf × 1	HF - dariy heifer, 2 months	Coccidiosis	Clinical examination & Treatment	1
04/09/2014	Cow × 1	HF - dairy cow, 3rd lactation	Toxic mastitis	Clinical examination & Treatment	1

08/09/2014	Steer × 1	Longhorn - beef steer, 15 months	Bacterial meningitis	Clinical examination & Treatment	2
08/09/2014	Cow × 1	AAX - beef heifer, 18 months	Corkscrew claw	Clinical examintion & advised cull	1
08/09/2014	Cow × 1	Jersey - dairy cow, 4th lactation	Traumatic Reticulo-Peritonitis	Clinical examination & Treatment	1
10/09/2014	Cow × 1	Friesian - dairy heifer, 1st lactation	Calving - head back	Delivery	1
11/09/2014	Steer × 1	Longhorn - beef steer, 15 months	Bacterial meningitis - re-exam	Clinical examination & Treatment	2
12/09/2014	Calves × 6	HF - dairy heifers, 8 months	Blood sampling for infectious disease screen	Blood sampling	1
12/09/2014	Calves × 12	HF - dairy heifers, 4 weeks	Pneumonia & scour	Clinical examination, Treatment and review of management	1
13/09/2014	Cow × 1	Simmental - beef heifer, 1st parity	Calving - emphysematous calf	Euthanasia	1
14/09/2014	Cow × 1	HF - dairy cow, 2nd lactation	Uterine Prolapse	Clinical examination & replacement	1
15/09/2014	Cow × 1	HF - dairy cow, 4th lactation	Downer Cow - hypophosphataemia	Clinical examination & Treatment	1
15/09/2014	Calves × 3	HF - dairy cow, 4 weeks	Pneumonia	Clinical examination & replacement	1
15/09/2014	Cow × 1	HF - dairy cow, 2nd lactation	Right displaced abomasum with volvulus	Clinical examination, laparotomy, gastrotomy and de-rotation	1
15/09/2014	Cow × 1	HF - dairy cow, 3rd lactation	Scouring cow - digestive upset	Clinical examination & Treatment	1
15/09/2014	Cow × 1	HF - dairy cow, 2nd lactation	Summer mastitis	Clinical examination & Treatment	1

16/09/2014	Steer × 1	AAX - beef steer, 17 months	Possible spinal injury	Clinical examination & emergency slaughter	1
17/09/2014	Cow × 1	HF - dairy cow, 3rd lactation	Left displaced abomasum	Clinical examination & surgical correction (right sided laparotomy & pyloropexy)	1
17/09/2014	Calves × 2	HF - dairy heifer, 2 weeks	Pneumonia	Clinical examination & Treatment	1
23/09/2014	Calves × 1	HF - dairy cow, 3 weeks	Pneumonia	Clinical examination & Treatment	1
24/09/2014	Cow × 1	HF - dairy heifer, 1st lactation	Cardiac insufficiency - pericarditis	Clinical examination, Treatment - advised poor prognosis	1
24/09/2014	Cow × 1	HF - dairy cow, 3rd lactation	Dislocated Hip	Clinical examination & emergency slaughter	1
24/09/2014	Cow × 1	HF - dairy cow, 2nd lactation	Peri-metritis/mild peritonitis	Clinical examination & Treatment	1
24/09/2014	Cow × 1	HF - dairy cow, 2nd lactation	Right displaced abomasum with volvulus	Clinical examination, laparotomy, gastrotomy and de-rotation	1
24/09/2014	Cow × 1	HF - dairy cow, 4th lactation	Vagal indigestion	Clinical examination & Treatment	1
25/09/2014	Cow × 1	HF - dairy cow, 4th lactation	Left displaced abomasum	Clinical examination & surgical correction (right sided laparotomy & pyloropexy)	1
25/09/2014	Cow × 1	HF - dairy cow, 3rd lactation	Nervous Ketosis	Clinical examination & Treatment	1
26/09/2014	Cow × 34	HF - dairy cow, various ages	Bacterial pneumonia - pasteurellosis	Clinical examination & Treatment	2

			outbreak secondary to lungworm		
29/09/2014	Bull × 1	Limousin - bull, 5 years	Toe ulcer & abscess	Clinical examination, trim, NSAIDs & antibiotics	1
30/09/2014	Cow × 1	Montbeliarde - dairy cow, 6th lactation	Haematoma on tuber ischii	Clinical examination & advised leave alone	1
01/10/2014	Cow × 1	HF - dairy heifer, 1 st lactation	Lungworm & secondary bacterial oneumonia	Clinical examination & Treatment	1
01/10/2014	Cow × 1	HF - dairy heifer, 1 st lactation	Lungworm & secondary bacterial oneumonia	Clinical examination & Treatment	1
02/10/2014	Cow × 1	Simmental - beef cow, 3rd parity	Caesarean section	Obstetric Surgery	1
02/10/2014	Cow × 1	HF - dairy cow, 3rd lactation	Clincial ketosis & metritis	Clinical examination & Treatment	1
02/10/2014	Cow × 1	HF - dairy cow, 4th lactation	Uterine Prolapse	Replacement	1
06/10/2014	Bull × 1	Limousin - beef bull, 18 months	Bull Breeding Soundness Examination	Clinical examination & semen collection/assessment	1
08/10/2014	Cow × 1	Montbeliarde - dairy cow, 6th lactation	Haematoma on tuber ischii	Surgical removal & sample collection for histopathology	1
09/10/2014	Cow × 1	Montbeliarde - dairy cow, 6th lactation	Wound management	Wound management	1
11/10/2014	Heifer × 1	Limousin X - beef heifer, 1st calving	Calving - anterior presentation	Delivery	1
11/10/2014	Steer × 1	Limousin X - beef steer, 24 months old	Hoof separation from corium on both back feet	Clinical examination & emergency slaughter	1
13/10/2014	Bull × 1	AA - beef bull, 5 months old	Castration	Surgical castration	1

13/10/2014	Heifer × 1	Limousin X - beef heifer, 15 months old	Sudden Death	Anthrax investigation	1
13/10/2014	Heifer × 1	Limousin - beef heifer, 1st calving	Uterine Prolapse	Replacement	1
15/10/2014	Cow × 1	HF - dairy cow, 5th lactation	Left Displaced Abomasum	Clinical examination & surgical correction (paramedian & abomasopexy)	1
22/10/2014	Cow × 1	Fr - dairy cow, 3rd lactation	Calving - head back	Correction and delivery	1
24/10/2014	Cow × 1	HF - dairy cow, 2nd lactation	Recumbent with right sided 'ping' - suspect RDA with volvulus	Clinical exmaination & euthanasia	1
24/10/2014	Cow × 1	HF - dairy cow, 2nd lactation	Retained foetal membranes and pyrexia	Clinical examination & treatment	1
29/10/2014	Bull × 5	Various breeds & ages	Bull Breeding Soundness Examination	Clinical examination & semen collection/assessment	1
29/10/2014	Cow × 1	HF - dairy cow, 4th lactation	Empyhsema under skin over back and flank	Clinical examination & treatment	1
29/10/2014	Bull × 1	AA - beef bull, 5 years old	Lame on front right foot	White line abscess & functional trim of other feet	1
29/10/2014	Bull × 1	Piedmontese - beef bull, 4 months old	Necrotic laryngitis	Emergency tracheostomy	1
03/11/2014	Cow × 1	HF - dairy cow, 3rd lactation	Left Displaced Abomasum	Clinical examination & surgical correction (right sided laparotomy & pyloropexy)	1
30/10/2014	Heifer × 1	HF - dairy heifer, 1st lactation	Pneumonia	Clinical examination & Treatment	1

05/11/2014	Cow × 1	HF - dairy cow, 5th lactation	Uterine torsion	Correction and delivery	1
06/11/2014	Cow × 1	HF - dairy cow, 6th lactation	Peritonitis	Clinical examination, ultrasound of the right flank, abdominocentesis & advised euthanasia	1
07/11/2014	Calf × 1	HF - dairy calf, 2 weeks	Scouring calf	Clinical examination & treatment (NSAIDs & oral fluids)	1
10/11/2014	Cow × 1	HF - dairy cow, 2nd lactation	Metritis & Ketosis	Clinical examination & treatment	1
12/11/2014	Cow × 1	Simmental - beef cow, 4th lactation	Breech calving - twins	Correction and delivery	1
17/11/2014	Cow × 26	HF - dairy cow, various ages	Johne's screening	Blood sampling	1
18/11/2014	Cow × 1	HF - dairy cow, 3rd lactation	Left Displaced Abomasum	Clinical examination & surgical correction (right sided laparotomy & pyloropexy)	1
18/11/2014	Steer × 1	AAX - beef steer, 10 months old	Fractured tibia/fibia	Clinical examination & euthanasia	1
	Date	27/11/2014	Date		
	Signature (Resident)	Andrew Henderson			

Annual Progress Report Submission Form

Individual Clinical Case Log (Sheet B)

Resident: Andrew Henderson

Institution: University of Nottingham

Primary Supervisor: Jon Huxley

Date: 21/11/2014

Year of Residency: One

Date	Farm ID	Farm type	Area or problem dealt with on farm	Activity of the Resident	Supervision
03/12/2013	Egg	Dairy Farm	Improving submission rates, mastitis & Johne's control around the point of calving	Farm visit, data collection, calculation and discussion of results & written report to the farmer	4
17/12/2013	Oul	Dairy Farm	Improving 1st service submission rate, improving cow comfort, Johne's and mastitis control around calving	Farm visit, data collection, calculation and discussion of results & written report to the farmer	4
02/01/2014	Fauk	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
03/01/2014	Jarr	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1

06/01 /2014	War	Dairy Farm	Routine Fertility	Pregnancy Diagnosis and Management of non - bullers	1
09/01 /2014	Bac	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
10/01 /2014	Adk	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
15/01 /2014	Whi	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
17/01 /2014	Jarr	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
20/01 /2014	War	Dairy Farm	Routine Fertility	Pregnancy Diagnosis and Management of non - bullers	1
20/01 /2014	War	Dairy Farm	Pneumonia problems in pre-weaned calves	Discussion on management of pneumonia in pre-weaned calves	1
21/01 /2014	Bow	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
23/01 /2014	Bac	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
24/01 /2014	Adk	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
29/01 /2014	Whi	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of	1

				non - bullers and Post natal checks	
29/01 /2014	Goo	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
30/01 /2014	Fauk	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
31/01 /2014	Jarr	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
03/02 /2014	War	Dairy Farm	Routine Fertility	Pregnancy Diagnosis and Management of non - bullers	1
04/02 /2014	Hol	Beef Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
05/02 /2014	Bro	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
06/02 /2014	Bac	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
17/02 /2014	War	Dairy Farm	Routine Fertility	Pregnancy Diagnosis and Management of non - bullers	1
19/02 /2014	Hay	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
20/02 /2014	Bac	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1

21/02/2014	Adk	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
25/02/2014	Bow	Dairy Farm	Routine Fertility & discussion of submission rates	Pregnancy Diagnosis, Management of non - bullers, Post natal checks and data analysis with on farm software	1
26/02/2014	Goo	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers, Post natal checks and improving submission rate	1
26/02/2014	Whi	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
27/02/2014	Fauk	Dairy Farm	Routine Fertility & discussion of Johne's ELISA screening results	Pregnancy Diagnosis, Management of non - bullers, Post natal checks and discussion of results	2
03/03/2014	War	Dairy Farm	Routine Fertility	Pregnancy Diagnosis and Management of non - bullers	1
04/03/2014	Hol	Beef Farm	Routine Fertility & discussion on yearly Johne's ELISA screening results	Pregnancy diagnosis & discuss Johne's herd screening	1
06/03/2014	Bac	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
07/03/2014	Adk	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1

11/03 /2014	Sew	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers, Post natal checks and discuss dry cow management	1
12/03 /2014	Whi	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
13/03 /2014	War	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
08/05 /2014	Bro	Dairy Farm	Control of contagious mastitis problem on farm and management of digital dermatitis problem	Farm visit, data collection, calculation and discussion of results & written report to the farmer	4
15/05 /2014	SBDC	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
29/05 /2014	SBDC	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
05/06 /2014	SDBC	Dairy Farm	Investigation of poor cure rates, increase of lactation origin clinical mastitis cases and summary of fertility	Farm visit, data collection, calculation and discussion of results & written report to the farmer	4
12/06 /2014	SBDC	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
19/06 /2014	Bac	Dairy Farm	Improving submission	Farm visit, data collection,	4

			rates, improvement of lactation origin clincal mastitis cases/seasonality problem & BVD control	calculation and discussion of results & written report to the farmer	
04/07/2014	Bro	Dairy Farm	Investigation of dry period origin clinical mastitis rate in heifers, heifer rearing and fertility performance	Farm visit, data collection, calculation and discussion of results & written report to the farmer	4
18/07/2014	Egg	Dairy Farm	Investigation of poor pregnancy rate, lameness, dry period management and Johne's	Farm visit, data collection, calculation and discussion of results & written report to the farmer	4
28/07/2014	Bac	Dairy Farm	Investigation of increasing lactation origin clincial mastitis rate, poor submission rate over summer and Johne's	Farm visit, data collection, calculation and discussion of results & written report to the farmer	4
11/03/2014	Cro	Dairy Farm	Discussion of submission rates/pregnancy rates and neccessity to improve recording of clincial mastitis	Farm visit, data collection, calculation and discussion of results & written report to the farmer	4
18/03/2014	Mil	Dairy Farm	Routine Fertility	Pregnancy Diagnosis × 11	1
20/03/2014	Bac	Dairy Farm	Routine Fertility & review colostrum management	Pregnancy Diagnosis, Management of non - bullers, Post natal checks, total protein sampling and protocol review	1
21/03/2014	Ad	Dairy Farm	Routine Fertility	Pregnancy Diagnosis,	1

				Management of non - bullers, Post natal checks and discuss need to record health events to allow data analysis	
08/04 /2014	Sew	Dairy Farm	Routine Fertility & discuss BVD screening results	Pregnancy Diagnosis, Management of non - bullers, Post natal checks and discuss BVD	1
08/04 /2014	Cro	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
09/04 /2014	Whi	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
10/04 /2014	Oul	Dairy Farm	Routine Fertility & discussion on subclinical ketosis	Pregnancy Diagnosis, Management of non - bullers, Post natal checks and discussion	1
14/04 /2014	Mor	Dairy Farm	Routine Fertility & discussion on installation of cluster flush system	Pregnancy Diagnosis, Management of non - bullers, Post natal checks and discussion	1
15/04 /2014	Bay	Dairy Farm	Routine Fertility	Post natal checks	1
16/04 /2014	Hay	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
17/04 /2014	Bac	Dairy Farm	Routine Fertility & discussion on dry cow management	Pregnancy Diagnosis, Management of non - bullers and Post natal checks and discussion of feed access in dry cows	1

18/04/2014	Adk	Dairy Farm	Routine Fertility & review colostrum management	Pregnancy Diagnosis, Management of non - bullers and Post natal checks and review colostrum management	1
22/04/2014	Bow	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
23/04/2014	Whi	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
23/04/2014	Goo	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
24/04/2014	Fauk	Dairy Farm	Routine Fertility & BVD	Pregnancy Diagnosis, Management of non - bullers, Post natal checks and discuss BVD	1
04/08/2014	Mor	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers, Post natal checks and discuss calf scour	1
06/08/2014	Hay	Dairy Farm	Routine Fertility & assessment of fertility parameters	Pregnancy Diagnosis, Management of non - bullers, Post natal checks and discuss fertility performance	1
06/08/2014	Goo	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
08/08/2014	Adk	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of	1

				non - bullers and Post natal checks	
12/08 /2014	Bow	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
13/08 /2014	Whi	Dairy Farm	Routine Fertility & discuss fertility performance	Pregnancy Diagnosis, Management of non - bullers, Post natal checks and discuss fertility, collect data and write report	1
01/09 /2014	War	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and discussion of pneumonia problems	1
03/09 /2014	Hay	Dairy Farm	Routine Fertility & udder health issues	Pregnancy Diagnosis, Management of non - bullers and discussion of mastitis parameters/control	1
03/09 /2014	Bro	Dairy Farm	Routine Fertility	Pregnancy Diagnosis	1
04/09 /2014	Bac	Dairy Farm	Routine Fertility & udder health issues	Pregnancy Diagnosis, Management of non - bullers and discussion of mastitis parameters	1
08/09 /2014	Whit	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
09/09 /2014	Bow	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1

07/08 /2014	Bac	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
15/09 /2014	War	Dairy Farm	Routine Fertility & on going pneumonia problems	Pregnancy Diagnosis, Management of non - bullers & discuss results of respiratory bloods	1
17/09 /2014	Bac	Dairy Farm	Routine Fertility & Johne's control	Pregnancy Diagnosis, Management of non - bullers, Post natal checks and discuss calving management of MAP positive/suspects	1
29/09 /2014	Mor	Dairy Farm	Routine Fertility & colostrum management review	Pregnancy Diagnosis, Management of non - bullers, Post natal checks and discussion on management of colostrum	1
01/10 /2014	Hay	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
01/10 /2014	God	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
02/10 /2014	Bac	Dairy Farm	Routine Fertility & review fertility parameters	Pregnancy Diagnosis, Management of non - bullers, Post natal checks and discussion on 1st service submission/fertility efficiency	1
03/10 /2014	War	Dairy Farm	Heifer Rearing - colostrum management, BVD progress,	Herd health discussion and planning for future growth	1

			housing management & growth rate assessment		
06/10 /2014	All	Dairy Farm	Lungworm outbreak - discussion future management	Discussion and write report	1
07/10 /2014	Bow	Dairy Farm	Routine Fertility & BVD discussion	Pregnancy Diagnosis, Management of non - bullers, Post natal checks and discussion of BVD monitoring	1
10/10 /2014	Jar	Dairy Farm	Routine Fertility	Post natal checks	1
14/10 /2014	Hol	Beef Farm	Routine Fertility	Pregnancy diagnosis & discussion on ventilation of bull shed (smoke bombing)	1
16/10 /2014	Bac	Dairy Farm	Routine Fertility & look at concerns over 1st lactation culling rate	Pregnancy Diagnosis, Management of non - bullers, Post natal checks and discussion on culling rate	1
17/10 /2014	Adk	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
21/10 /2014	Sew	Dairy Farm	Routine Fertility & ketosis monitoring	Pregnancy Diagnosis, Management of non - bullers and Post natal checks and discussion on subclinical ketosis monitoring	1
21/10 /2014	Cro	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
22/10 /2014	Whi	Dairy Farm	Routine Fertility	Pregnancy Diagnosis,	1

				Management of non - bullers and Post natal checks	
27/10 /2014	War	Dairy Farm	Routine Fertility & planning of new housing requirements for calves	Pregnancy Diagnosis & discussion on calf pneumonia management and purchase of new housing	1
28/10 /2014	Bay	Dairy Farm	Routine Fertility & discuss feed access problems	Management of non - bullers, Post natal checks and discussion of feed barrier improvements	1
28/10 /2014	Goo	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
29/10 /2014	Hay	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
30/10 /2014	Bac	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
31/10 /2014	Adk	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
31/10 /2014	Adk	Dairy Farm	AI Refresher Course - semen handling and assessment of service technique	Farm visit, data collection, calculation and discussion of results & written report to the farmer	1
04/11 /2014	Bow	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
04/11 /2014	Bow	Dairy Farm	Review of fertilty parameters on	Farm visit, data collection, calculation and	1

			Total Vet & discussion about BVD	discussion of results & written report to the farmer	
07/11 /2014	Jar	Dairy Farm	Routine Fertility	Post natal checks	1
10/11 /2014	War	Dairy Farm	Routine Fertility	Pregnancy Diagnosis	1
13/11 /2014	Bac	Dairy Farm	Routine Fertility & Herd health discussion	Pregnancy Diagnosis, Management of non - bullers, Post natal checks & discussion of poor dry period cure rate	1
14/11 /2014	Adk	Dairy Farm	Routine Fertility & Herd health discussion	Pregnancy Diagnosis, Management of non - bullers, Post natal checks & discussion on poor 1st service timing	1
	Date	27/11/2014	Date		
	Signature (Resident)	Andrew Hardgrave			

Annual Progress Report Submission Form

Conferences, Congresses and Professional Meetings attended Log (Sheet D)

Resident: Andrew Henderson | Institution: University of Nottingham

Primary Supervisor: Jon Huxley | Date: 21/11/2014 | Year of Residency: One

Date	Duration	Name of Meeting / Location
30/04/2014	3 days	Residents Workshop (Bologna)
23/06/2014	1 day	University of Nottingham Fertility Conference
24/06/2014	1 day	University of Nottingham Nutrition Conference
17 - 18/10/2014	2 days	BCVA Annual Congress
11 - 12/11/2014	2 days	British Mastitis Conference

Date	27/11/2014	Date	
Signature (Resident)	Andrew Henderson	Signature (Supervisor)	

Annual Progress Report Submission Form

Lectures and Seminars given Log (Sheet G)

Resident: Andrew Henderson | Institution: University of Nottingham

Primary Supervisor: Jon Huxley | Date: 21/11/2014 | Year of Residency: One

Date	Duration and Location	Type of event	Topic	Participants
09/04/2014	20 minutes Scarsdale Veterinary Group	Final Year Rotations - Seminar	BVD & Johnes	Final year vet students × 4
16/04/2014	20 minutes Scarsdale Veterinary Group	Final Year Rotations - Seminar	Basic Nutrition	Final year vet students × 4
13/05/2014	1 day School of Veterinary Medicine & Science University of Nottingham	1st Year Neurology Examination Practicals	Neurological examination of cattle & sheep	1st year vet students × 50
14/05/2014	1 day School of Veterinary Medicine & Science University of Nottingham	4th Year Teat Surgery Practical	Teat Surgery	4th year vet students × 60
23/05/2014	40 minutes School of Veterinary Medicine & Science University of Nottingham	Farm Animal Rounds, University of Nottingham	Body condition scoring - Penn State Method	Postgraduate students and clinical staff × 12
06/06/2014	30 minutes School of Veterinary Medicine & Science University of Nottingham	Farm Animal Rounds, University of Nottingham	Rumen Protected Choline feeding in transition cows - 20 minutes	Postgraduate students and clinical staff × 10
20/06/2014	30 minutes School of Veterinary Medicine & Science University of Nottingham	Farm Animal Rounds, University of Nottingham	Selective Dry Cow Therapy in low somatic cell count cows - 20 minutes	Postgraduate students and clinical staff × 8
04/07/2014	30 minutes School of Veterinary Medicine & Science University of Nottingham	Farm Animal Rounds, University of Nottingham	Recent spatial changes in bovine tuberculosis in the Republic of Ireland	Postgraduate students and clinical staff × 7
17/07/2014	30 minutes School of Veterinary Medicine & Science University of Nottingham	Farm Animal Rounds, University of Nottingham	Reproductive performance of seasonally calving herds in New Zealand - the InCalf Project	Postgraduate students and clinical staff × 5
15/10/2014	20 minutes Scarsdale Veterinary Group	Final Year Rotations - Seminar	Bovine Viral Diarrhoea Virus	Final year vet students × 4
21/10/2014	20 minutes Scarsdale Veterinary Group	Final Year Rotations - Seminar	Using Total Vet - Assessing Fertility Performance	Final year vet students × 4
24/10/2013	30 minutes School of Veterinary Medicine & Science University of Nottingham	Farm Animal Rounds, University of Nottingham	Approach to the Blind Steer	Postgraduate students and clinical staff × 5
27/10/2014	60 minutes Scarsdale Veterinary Group	Farmer Meeting	Bull Breeding Soundness Examinations	Associate Practice clients (farmers) × 8
21/11/2014	30 minutes School of Veterinary Medicine & Science University of Nottingham	Farm Animal Rounds, University of Nottingham	Use of on farm culture in treatment of clinical cases of mastitis	Postgraduate students and clinical staff × 8

Date	27/11/2014	Date	
Signature (Resident)	A. Jones Henderson	Signature (Supervisor)	

Annual Progress Report Submission Form

Lectures and Seminars attended Log (Sheet F)

Resident: Andrew Henderson | Institution: University of Nottingham

Primary Supervisor: Jon Huxley | Date: 21/11/2014 | Year of Residency: One

Date	Duration	Topic	Type of event / Location	Speaker	Participants
06/12/2013 - Fortnightly	3 hrs	Dairy Herd Health	Farm Animal Rounds, University of Nottingham	Various	Final years, residents and Clinical staff ×10
08/01/2014	1 day	Green Bedding & Red Tractor Assurance Scheme	Nottingham Dairy Herd Health Group, University of Nottingham	Katherine Leach, Christopher Hudson, Jon Statham	Academic staff, postgraduates and clinicians × 12
Apr-14	1 hrs	Ultrasonography	ECBHM Webinar	Sebastien Buckinski	ECBHM Residents
Apr-14	1 hrs	Bull Breeding	ECBHM Webinar	John Kastelic	ECBHM Residents
Apr-14	1 hrs	Schmallenberg	ECBHM Webinar		ECBHM Residents
Apr-14	1 hrs	Acid - Base Balance Calves	ECBHM Webinar	Ingrid Lonrenz	ECBHM Residents
06/06/2014	0.5 hrs	Removal of a bovine melanoma	Farm Animal Rounds, University of Nottingham	Virginia Sherwin	Postgraduates and clinical staff × 12
20/06/2014	0.5 hrs	Prognostic indicators for LDA/RDA surgery	Farm Animal Rounds, University of Nottingham	Virginia Sherwin	Postgraduates and clinical staff × 12
04/07/2014	0.5 hrs	Lameness Research Project	Farm Animal Rounds, University of Nottingham	Oliver Maxwell	Postgraduates and clinical staff × 9
09/07/2014	1 day	Green Bedding & BVD	Nottingham Dairy Herd Health Group, University of Nottingham	Martin Green, Jon Statham	Academic staff, postgraduates and clinicians × 8
23/07/2014	1 day	Advanced Total Vet use	Taurus CPD - Total Vet Advanced user course, Cheddar	Andrew Bradley & James Breen	Practitioners × 12
31/07/2014	1 day	Using Microsoft Word	Managing Long Documents in Word, University of Nottingham	Tracy Hassall - Jones	Postgraduate students × 20
01/08/2014	0.5 hrs	Bovine TB journal article review	Farm Animal Rounds, University of Nottingham	Oliver Maxwell	Postgraduates and clinical staff × 7
30/09/2014	1.5 hrs	The Middle Tier	RCVS Advanced Practitioner Status Webinar	Kit Sturgess	Practitioners
08/10/2014	1.5 hrs	BCS, Rumen Fill & housing	ELANCO Transition Cow Management Workshop	Owen Atkinson	Practitioners × 15
10/10/2014	0.5 hrs	Review of literature on treatment of metritis	Farm Animal Rounds, University of Nottingham	Oliver Maxwell	Postgraduates and clinical staff × 7
10/10/2014	0.5 hrs	Meta - analysis of endometritis treatment	Farm Animal Rounds, University of Nottingham	Ginny Sherwin	Postgraduates and clinical staff × 7
24/10/2014	0.5 hrs	Investigation of an outbreak of respiratory disease in a dairy herd	Farm Animal Rounds, University of Nottingham	Ginny Sherwin & Oli Maxwell	Postgraduates and clinical staff × 8
07/11/2014	0.5 hrs	Review of national Johne's control programs in Europe	Farm Animal Rounds, University of Nottingham	Ginny Sherwin	Postgraduates and clinical staff × 8
07/11/2014	0.5 hrs	Review of paper on Mobility Scoring	Farm Animal Rounds, University of Nottingham	Oliver Maxwell	Postgraduates and clinical staff ×8
Date	27/11/2014	Date			
Signature (Resident)	Andrew Henderson	Signature (Supervisor)			

Annual Progress Report Submission Form

Anicillary Topics Case Log - Pathology/Necropsies (Sheet C)

Resident: Andrew Henderson | Institution: University of Nottingham

Primary Supervisor: Jon Huxley | Date: 21/11/2014 | Year of Residency: One

Date	Animal ID	Animal Category (species, type, sex, age)	Diagnosis	Activity of the resident	Supervision
22/02/2014		HF - dairy cow, 4th lactation	Adenocarcinoma of the bladder	Performed necropsy	1
13/04/2014		Beef steer, 18 months	Pleuro-pneumonia	Performed necropsy	1
12/08/2014		Beef calf, Simmental abortion	Unknown cause of abortion	Performed necropsy	5
26/09/2014		HF - dairy cow, 4th lactation	Pleuro-pneumonia	Performed necropsy	1
26/09/2014		HF - dairy cow, 3th lactation	Pleuro-pneumonia	Performed necropsy	1
26/02/2014		Belgian Blue X - beef calf, 5 months olds	Cerebro-cortical necrosis	Performed necropsy	1

Date	27/11/2014	Date	
Signature (Resident)	Andrew Henderson	Signature (Supervisor)	

Annual Progress Report Summary Sheet

Resident: Andrew Henderson | Institution: University of Nottingham

Primary Supervisor: Jon Huxley | Date: 21/11/2014 | Year Of Residency: One

Training Element	Numbers
Individual clinical cases	232
Herd health cases	105
Ancillary topics - Pathology/Necropsies	5
Conferences, congresses and professional meetings attended	5
Presentations at conferences, congresses and professional meetings	0
Lectures and seminars attended	30
Lectures and seminars given	14

Date:	27/11/2014
Signature (Resident):	Andrew Henderson
Date:	
Signature (Supervisor):	

11.11.2 Year Two ECBHM Residency Case Log

Annual Progress Report Submission Form

Individual Clinical Case Log (Sheet A)

Resident: Andrew Henderson

Institution: University of Nottingham

Date: 20/1 1/20 15

Primary Supervisor: Jon Huxley

Year of Residency: Two

Date	Patient ID	Patient Category (species, type, sex, age)	Diagnosis	Clinical activity of the resident	Supervision
04/10/2015	Cow × 1	Lim - beef heifer	11 days past due date, induced but not beginning to calf	Caesarean section	1
11/09/2015	Calf × 1	Hol - dairy calf, 4 days old	Atresia coli	Blood gas, fluid therapy, right flank laparotomy & euthanasia	6
24/06/2015	Bull × 1	Hereford - 3 years old	Bull Breeding Soundness Examination	Bull Breeding Soundness Examination	1

06/06/2015	Cow × 1	British White - beef heifer, 17 months	C - section	Obstetric surgery	1
06/06/2015	Cow × 1	Hol - dairy heifer, 23 months	C - section	Obstetric surgery	1
16/06/2015	Calf × 1	Shorthorn - beef bull, 3 weeks	Calf diphtheria	Clinical examination & treatment	1
15/03/2015	Cow × 1	Hol - dairy cow, 1st lactation	Calving	Delivery & episiotomy	1
16/06/2015	Cow × 1	Belgian Blue X - beef cow, 2nd parity	Calving	Delivery	1
17/06/2015	Cow × 1	Montbelliarde - dairy cow, 1st lactation	Calving	Delivery	1
21/06/2015	Cow × 1	BBX - beef cow, 1st parity	Calving	Delivery	1
01/06/2015	Cow × 1	Hol - dairy cow, 5th lactation	Calving - breech twins	Delivery	1
08/06/2015	Cow × 1	Char - beef cow, 5th aprity	Calving - calf stuck at hips	Embryotomy and delivery	1
21/06/2015	Cow × 1	Sim - beef cow, 4th parity	Calving - foeto-maternal oversize	Caesarean section	1
13/12/2014	Cow × 1	Fr - dairy cow, 6th lactation	Calving - head back	Correction and delivery	1

15/06/2015	Cow × 1	Hol - dairy cow, 3rd lactation	Calving - head back/C - section	Obstetric surgery	1
05/06/2015	Cow × 1	Hol - dairy cow, 1st lactation	Calving - leg back	Delivery	1
03/06/2015	Cow × 1	Lim - beef heifer	Calving - posterior presentation	Delivery	1
08/09/2015	Cow × 1	Hol - dairy cow, 3rd lactation	Carpal bursitis	Ultrasonography of carpus	6
10/09/2015	Calf × 1	Hol - dairy calf, 1 week old	Diarrhoea and collapsed	Blood gas, biochemistry and Intravenous fluid therapy	6
04/10/2015	Cow × 1	Hol - dairy cow, 4th lactation	Down cow	Diagnosis & treatment	1
07/06/2015	Cow × 1	Hol - dairy cow, 4 th lactation	E. coli mastitis	Clinical examination & treatment (IV fluids therapy)	1
04/10/2015	Cow × 1	Hol - dairy cow, 2nd lactation	E. coli mastitis	Diagnosis, treatment (antibiotics, NSAIDs & oral fluids)	1
19/02/2015	Calf × 1	Hol - dairy heifer, 3 days old	E.coli septicaemia	Clinical examination & treatment	1
12/03/2015	Cow × 1	Hol - dairy cow, 5th lactation	Exploratory Laparotomy - loss of body condition, milk yield and malaise	Hepatitis & liver biopsy	1
19/12/2014	Calf × 1	HF - dairy heifer, 6 weeks	Fracture of hind left leg mid	Apply fibre glass cast	1

			meta-tarsal		
24/04/2015	Cow × 1	Simmental - beef cow, 3rd parity	Generalised peritonitis	Clinical examination & euthanasia	1
24/06/2015	Cow × 1	Shorthorn - dairy cow, 4th parity	Heart failure	Diagnosis & euthanasia	1
03/06/2015	Calf × 1	Lim - beef heifer, 4 weeks	Infected urachus	Clinical examination & treatment	1
10/07/2015	Cow × 1	Hol - dairy cow, 4th lactation	Infectious bovine keratoconjunctivitis	Diagnosis & treatment	1
07/09/2015	Cow × 1	Brown Swiss - dairy cow, 2nd lactation	Intermittent pyrexia for 2 months	Haematology, thoracic radiography, ultrasonography & rumenotomy to remove foreign body	6
24/04/2015	Cow × 1	Hol - dairy cow, 2nd lactation	Intestinal torsion	Exploratory laparotomy and euthanasia	1
20/07/2015	Cow × 1	Hol - dairy cow, 3rd lactation	Intestinal torsion	Right flank exploratory laparotomy & euthanasia	1
27/02/2015	Cow × 1	Hol - dairy cow, 3rd lactation	Ketosis	Clinical examination & treatment	1
03/03/2015	Cow × 1	Hol - dairy cow, 2nd lactation	Lame - foul	Clinical examination & treatment	1
28/02/2015	Cow × 1	Hol - dairy cow, 3rd lactation	Lame - sole ulcer	Trim, block & NSAIDs	1
01/03/2015	Cow × 1	Hol - dairy cow, 3rd lactation	Lame - whilte line ulcer	Trim, block & NSAIDs	1

02/03/2015	Cow × 1	Hol - dairy cow, 3rd lactation	Lame - wound on cranio-medial aspect of left hind stifle	Debride, flush, antibiosis & NSAIDs	1
11/09/2015	Cow × 1	Erringer - cow, 2nd lactation	Lame left hind	Examination, radiography, ultrasonography, trim, block & NSAIDs	6
08/09/2015	Cow × 1	Hol - dairy cow, 4th lactation	Large oedematous swelling below lower mandible	Ultrasonography, radiography, endoscsopy, cytology and culture	6
03/12/2014	Cow × 1	HF - dairy cow, 3rd lactation	Left displaced abomasum	Right flank laparotomy & pyloropexy	1
26/02/2015	Cow × 1	Hol - dairy cow, 3rd lactation	Left displaced abomasum	Right flank laparotomy & pyloropexy	1
05/03/2015	Cow × 1	Hol - dairy cow, 3rd lactation	Left displaced abomasum	Right flank laparotomy & pyloropexy	1
01/04/2015	Cow × 1	Hol - dairy cow, 4th lactation	Left displaced abomasum	Right flank laparotomy & pyloropexy	1
22/04/2015	Cow × 1	Hol - dairy cow, 4th lactation	Left displaced abomasum	Right flank laparotomy & pyloropexy	1
24/04/2015	Cow × 1	Hol - dairy cow, 4th lactation	Left displaced abomasum	Right flank laparotomy & pyloropexy	1
23/06/2015	Cow × 1	Hol - dairy cow, 2nd lactation	Left displaced abomasum	Right flank laparotomy & pyloropexy	1
15/07/2015	Cow × 1	Hol - dairy	Left displaced	Right flank laparotomy & pyloropexy	1

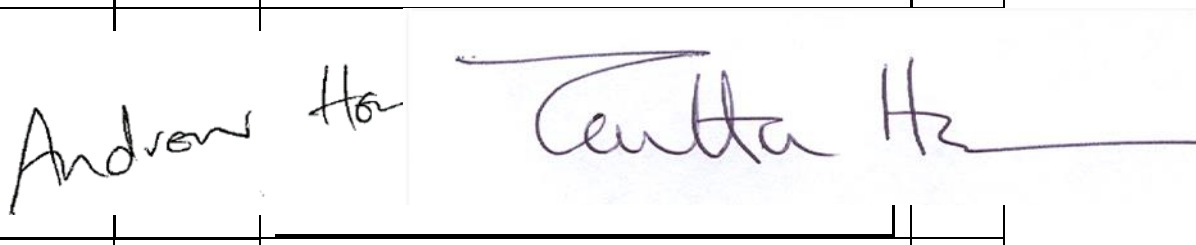
		cow, 3rd lactation	abomasum		
10/07/2015	Cow × 1	Hol - dairy cow, 3 rd lactation	Left displaced abomasum	Right flank laparotomy & pyloropexy	1
09/06/2015	Cow × 1	Hol - dairy heifer, 1st lactation	Left displaced abomasum	Right flank laparotomy & pyloropexy	1
09/06/2015	Cow × 1	Hol - dairy cow, 2nd lactation	Left displaced abomasum	Right flank laparotomy & pyloropexy	1
10/09/2015	Cow × 1	Hol - dairy cow, 2nd lactation	Left displaced abomasum	Blood gas, fluid therapy, right flank laparotomy & omentopexy	4
17/12/2014	Cow × 1	HF - dairy heifer, 1st lactation	Left displaced abomasum, peritonitis and possible vagal indigestion	Exploratory laparotomy and euthanasia	1
09/09/2015	Cow × 1	Hol - dairy heifer, 1st lactation	Left displaced abomasum, reticular adhesions & abomasal ulcer	Haematology, thoracic radiography, ultrasonography, left flank laparotomy & euthanasia	4
12/03/2015	Cow × 1	Hol - dairy cow, 2nd lactation	Mastitis	Clinical examination & treatment	1
01/06/2015	Cow × 1	AAX - beef cow, 4th parity	Mastitis	Clinical examination & treatment	1

19/06/2015	Cow × 1	Hol - dairy cow, 3rd lactation	Metritis	Diagnosis & treatment	1
26/06/2015	Cow × 1	Hol - dairy cow, 4th lactation	Metritis	Diagnosis & treatment	1
26/06/2015	Cow × 1	Hol - dairy heifer, 1st lactation	Metritis	Diagnosis & treatment	1
10/07/2015	Cow × 1	Hol - dairy heifer, 1 st lactation	Metritis	Diagnosis & treatment	1
10/07/2015	Cow × 1	Hol - dairy heifer, 1 st lactation	Metritis	Diagnosis & treatment	1
10/07/2015	Cow × 1	Hol - dairy heifer, 1 st lactation	Metritis	Diagnosis & treatment	1
23/06/2015	Cow × 1	Hol - dairy cow, 4th lactation	Metritis	Diagnosis & treatment	1
14/02/2015	Cow × 1	Dairy shorthorn - dairy cow, 5th lactation	Milk fever	Clinical examination & treatment	1
21/06/2015	Cow × 1	Hol - dairy cow, 3rd lactation	Milk Fever	Diagnosis & treatment	1
15/12/2014	Heifer × 3	Hereford X - beef heifer, 8 months old	Misalliance	Diagnosis & treatment to induce abortion	1
20/06/2015	Cow × 1	Hol - dairy heifer, 1st lactation	Nervous ketosis & pneumonia	Diagnosis & treatment	1

02/09/2015	Bull × 1	Charolais - 4 years	Orchitis	Diagnosis and recommend slaughter whne recovered	7
23/12/2014	Cow × 1	HF - dairy cow, 2nd lactation	Peroneal nerve paralysis of left hind leg	Clinical examination & treatment	1
23/12/2014	Calf × 3	AA - beef steers, 5 months	Pneumonia	Clinical examination & treatment	1
01/07/2015	Calf ×1	AAX - beef calf, 4 weeks	Pneumonia	Diagnosis & treatment	1
03/10/2015	Calf × 1	Hol - dairy calf, 3 weeks	Pneumonia	Diagnosis & treatment	1
12/03/2015	Bull × 1	Saler - beef bull, 2 years	Pre - sale bull breeding soundess examination	Bull breeding soundness examination	1
02/09/2015	Bull × 1	Welsh black - 24 months	Pre - sale bull breeding soundess examination	Bull breeding soundness examination	7
02/09/2015	Bull × 1	Welsh black - 24 months	Pre - sale bull breeding soundess examination	Bull breeding soundness examination	7
02/09/2015	Bull × 1	Charolais - 5 years	Pre - sale bull breeding soundess examination	Bull breeding soundness examination	7
02/09/2015	Bull × 1	Welsh black - 3 years	Pre - sale bull breeding soundess examination	Bull breeding soundness examination	7

02/09/2015	Bull × 1	Charolais - 18 months	Pre - sale bull breeding soundess examination	Bull breeding soundness examination	7
02/09/2015	Bull × 1	Charolais - 15 months	Pre - sale bull breeding soundess examination	Bull breeding soundness examination	7
14/07/2015	Cow × 1	Lim - beef heifer	Pyrexia of unknown origin	Diagnosis & treatment	1
25/12/2014	Cow × 1	Fr - dairy heifer, 1st lactation	Relative foeto-maternal oversize - calving	Caesarean section	1
07/09/2015	Calf × 1	Hol - dairy calf, 1 month old	Right displaced abomasum	Right flank laparotomy, deflation and IV fluid therpay	4
15/07/2015	Cow × 1	Hol - dairy cow, 3 rd lactation	Right displaced abomasum with metritis	Conservative/medical treatment	1
23/12/2014	Cow × 1	HF - dairy heifer, 1st lactation	Right displaced abomasum with volvulus	Right flank laparotomy, gastrotomy, deflation, de-rotation & pyloropexy	1
07/09/2015	Cow × 1	Fleckvieh - dairy cow, 3rd lactation	Right displaced abomasum with volvulus	Right flank laparotomy, deflation, de-rotation and omentopexy with IV fluid therpay	4
24/04/2015	Cow × 1	Hol - dairy cow, 2nd lactation	Right sided heart failure	Clinical examination & euthanasia	1
01/04/2015	Cow × 1	AA - beef heifer, 29 months	Salmonellosis	Clinical examination & treatment	1

02/10/2015	Cow × 1	Hol - dairy cow, 3rd lactation	Severe peritonitis	Diagnosis and recommended slaughter	1
12/03/2015	Bull × 1	Limousin - beef bull, 4 years	Sub fertility examination	Bull breeding soundness examination	1
05/06/2015	Cow × 1	Hol - dairy cow, 1st lactation	Subclinical ketosis	Clinical examination & treatment	1
15/06/2015	Cow × 1	Hol - dairy cow, 5th lactation	Sudden death	Statutory anthrax investigation	1
15/07/2015	Cow × 1	Ayrshire - dairy heifer, 1st lactation	Teat pea	Remove	1
12/12/2014	Cow × 1	HF - dairy cow, 2nd lactation	Toxic metritis with retained foetal membranes	Clinical examination & treatment	1
12/03/2015	Cow × 1	Hol - dairy cow, 3rd lactation	Traumatic Reticulo-Peritonitis	Clinical examination & treatment	1
14/02/2015	Cow × 1	Hol - dairy cow, 3rd lactation	Uterine prolapse	Correction & treatment	1
15/06/2015	Cow × 1	Hol - dairy cow, 5th lactation	Uterine prolapse	Replacement	1
21/06/2015	Cow × 1	Montbelliarde - dairy cow, 1st lactation	Uterine prolapse	Replacement	1
09/06/2015	Cow × 1	Hereford - beef cow, 8th parity	Uterine torsion	Delivery	1

14/02/2015	Cow × 1	Hol - dairy cow, 3rd lactation	Vagal indigestion/TRP	Clinical examination & treatment	1
15/03/2015	Cow × 1	Simmental X - beef heifer, 1st lactation	Vaginal & rectal prolapse	Epidural & replacement	1
01/06/2015	Cow × 1	Montbeliarde - dairy cow, 1st lactation	Wooden tongue (Actinobacillus ligneresii)	Clinical examination & treatment	1
	Date	20/11/2015	Date	24/11/2015	
	Signature (Resident)				

Annual Progress Report Submission Form

Individual Clinical Case Log (Sheet B)

Resident: Andrew Henderson

Institution: University of Nottingham

Primary Supervisor: Jon Huxley

Date: 20/11/2015

Year of Residency: Two

Date	Farm ID	Farm type	Area or problem dealt with on farm	Activity of the Resident	Supervision
01/12/2014	Woo	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
02/12/2014	Bow	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1

02/12/2014	Sew	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
03/12/2014	Whi	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
05/12/2014	Jar	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
08/12/2014	Adk	Dairy Farm	Herd Health Discussion - Planning set up of new dairy, robotic milkers and cubicle sheds	Discussion with farmer, nutritionist, adviser and Westfalia consultants re set up	1
08/12/2014	War	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
09/12/2014	Hol	Beef Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
10/12/2014	Bear	Dairy Farm	Routine Fertility & Herd Health Discussion	Pregnancy Diagnosis, Management of non - bullers and Post natal checks & discussion	1

				on drying off technique with Orbeseal and herd management of fasciola	
11/12/2014	Bac	Dairy Farm	Routine Fertility & Herd Health Discussion	Pregnancy Diagnosis, Management of non - bullers and Post natal checks & discussion of poor lactation origin index clinical mastitis cases	2
12/12/2014	Adk	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
16/12/2014	Sew	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
16/12/2014	Croo	Dairy Farm	Routine Fertility & Herd Health Discussion	Pregnancy Diagnosis, Management of non - bullers and Post natal checks & discussion regarding poor pregnancy rate and changes to housing	1

				that could be made to help	
17/12/2014	Whi	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
18/12/2014	Bro	Dairy Farm	Herd Health Discussion -poor performance (milk yields)	Ration evaluation and on farm walk to explore reasons for poor performance - clamp management, feed access, water access …..	1
19/12/2014	Jar	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
24/12/2014	Bac	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	2
21/01/2015	SBDC	Dairy Farm	Herd Health Monitoring	Body condition & mobility scoring half the herd & report generation	2
03/02/2015	Hill	Dairy Farm	Herd Health Discussion	Farm Visit & Data Analysis - Fertility & Somatic Cell Count	4

				Data & Report writing	
05/02/2015	SBDC	Dairy Farm	Herd Health Monitoring	Body condition & mobility scoring half the herd & report generation	2
09/02/2015	Arl	Dairy Farm	Herd Health Discussion	Farm Visit, Data Analysis & Report writing - Pre-weaned, growing, bulling, in calf and 1st lactation heifers: review of DLWG, mortality, disease treatments, udder health & fertility	4
19/02/2015	SBDC	Dairy Farm	Herd Health Discussion	Body condition & mobility scoring half the herd & report generation	2
23/02/2015	Bro	Dairy Farm	Herd Health Discussion	Farm Visit, Data Analysis & Report writing - Pre-weaned heifer pneumonia & DLWG, herd review of lameness, udder	4

				health, BCS & fertility	
05/03/2015	SBDC	Dairy Farm	Herd Health Monitoring	Body condition & mobility scoring half the herd & report generation	2
09/03/2015	Whi	Dairy Farm	Herd Health Discussion	Farm Visit, Data Analysis & Report Writing - Mastitis: SCC new infection in dry period, seasonal clinical mastitis lactation problem, mobility score assessment & fertility review	4
19/03/2015	SBDC	Dairy Farm	Herd Health Monitoring	Body condition & mobility scoring half the herd & report generation	2
23/03/2015	Sha	Dairy Farm	Herd Health Discussion	Farm Visit, Data Analysis & Report Writing - Fertility review: sub-optimal pregnancy rate and return servive submission	4
01/04/	Hay	Dairy	Herd Health Discussion	Farm Visit, Data	4

2015		Farm		Analysis & Report Writing - Fertility review: sub-optimal pregnancy rate and return servive submission	
02/04/2015	SBDC	Dairy Farm	Herd Health Monitoring	Body condition & mobility scoring half the herd & report generation	2
06/04/2015	Egg	Dairy Farm	Herd Health Discussion	Farm Visit, Data Analysis & Report Writing - Mastitis: sub-optimal dry period new infection rate & dry period origin clinical mastitis; Fertility: review last 12 weeks breeding period	4
16/04/2015	SBDC	Dairy Farm	Herd Health Monitoring	Body condition & mobility scoring half the herd & report generation	2
20/04/2015	Adk	Dairy Farm	Herd Health Monitoring	Farm Visit, Data Analysis & Report Writing -	1

				Metabolic health review: milk fever investigation and fresh cow health (mastitis)	
22/04/2015	Gre	Beef Farm	Routine Fertility	Pregnancy Diagnosis	1
26/05/2015	War	Dairy Farm	Routine Fertility	Pregnancy Diagnosis	1
26/05/2015	Goo	Dairy Farm	Routine Fertility	Pregnancy Diagnosis	1
27/05/2015	Holl	Beef Farm	Routine Fertility	Pregnancy Diagnosis	1
28/05/2015	Bac	Dairy Farm	Routine Fertility & Herd Health Discussion	Pregnancy Diagnosis, Management of non - bullers, Post natal checks and discussion on high clinical mastitis rate	2
02/06/2015	Croo	Dairy Farm	Routine Fertility & Herd Health Discussion	Pregnancy Diagnosis, Management of non - bullers, Post natal checks and discussion	1
02/06/2015	Sew	Dairy Farm	Routine Fertility & Herd Health Discussion	Pregnancy Diagnosis, Management of non - bullers, Post natal checks and	1

				discussion on management of digital dermatitis	
04/06/2015	Bac	Dairy Farm	Routine Fertility	Pregnancy Diagnosis	2
08/06/2015	War	Dairy Farm	Routine Fertility	Pregnancy Diagnosis	1
09/06/2015	Goo	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
12/06/2015	Adk	Dairy Farm	Routine Fertility & Herd Health Discussion	Pregnancy Diagnosis, Management of non - bullers and Post natal checks; discussion improving 1st serve submission rate	1
16/06/2015	Bow	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
18/06/2015	Bac	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	2
19/06/2015	Adk	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and	1

				Post natal checks	
22/06/2015	War	Dairy Farm	Routine Fertility	Pregnancy Diagnosis	1
23/06/2015	Goo	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
24/06/2015	Gru	Beef Farm	Routine Fertility	Pregnancy Diagnosis	1
26/06/2015	Adk	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
30/06/2015	Croo	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
02/07/2015	Bac	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	2
07/07/2015	War	Dairy Farm	Routine Fertility	Pregnancy Diagnosis	1
09/07/2015	Bac	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	2
10/07/	Adk	Dairy	Routine Fertility	Pregnancy Diagnosis,	1

2015		Farm		Management of non - bullers and Post natal checks	
14/07/2015	Bow	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	1
15/07/2015	Bac	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	2
20/07/2015	War	Dairy Farm	Routine Fertility	Pregnancy Diagnosis	1
12/08/2015	Egg	Dairy Farm	Herd Health Discussion	Farm Visit, Data Analysis & Report Writing - Summary of first 6 weeks of breeding (submission rate & pregnancy rate), udder health and foot health performance	4
13/08/2015	SBDC	Dairy Farm	Herd Health Monitoring	Body condition & mobility scoring quarter of the herd & report generation	2
24/08/	White	Dairy	Herd Health Discussion	Farm Visit, Data	4

2015		Farm		Analysis & Report Writing - Investigation of dry period origin somatic cell count issues in heifers, feed management to improve yield and morbidity in pre-weaned calves	
27/08/2015	SBDC	Dairy Farm	Herd Health Monitoring	Body condition & mobility scoring quarter of the herd & report generation	2
10/09/2015	SBDC	Dairy Farm	Herd Health Monitoring	Body condition & mobility scoring quarter of the herd & report generation	2
21/09/2015	Hill	Dairy Farm	Herd Health Discussion	Farm Visit, Data Analysis & Report Writing - Investigation of poor transition health (RFM, metritis, subclinical hypocalcaemia & pregnancy	4

				rate) and summary of improvements to be made in submission rates	
24/09/2015	SBDC	Dairy Farm	Herd Health Monitoring	Body condition & mobility scoring quarter of the herd & report generation	2
05/10/2015	Bir	Dairy Farm	Herd Health Discussion	Farm Visit, Data Analysis & Report Writing - Investigation of possible issue with late embryonic death and poor pregnancy rates; review of clinical mastitis.	2
08/10/2015	SBDC	Dairy Farm	Herd Health Monitoring	Body condition & mobility scoring quarter of the herd & report generation	2
19/10/2015	Oul	Dairy Farm	Herd Health Discussion	Farm Visit, Data Analysis & Report Writing - Investigation of 1st service submission	4

				rate, pregnancy rate & calf health	
22/10/2015	SBDC	Dairy Farm	Herd Health Monitoring	Body condition & mobility scoring quarter of the herd & report generation	2
16/11/2015	Arl	Dairy Farm	Herd Health Discussion	Data Analysis - Fertility anlaysis of split block calving herd (spring and summer service periods) & mastitis analysis	4
19/11/2015	SBDC	Dairy Farm	Herd Health Monitoring	Body condition & mobility scoring quarter of the herd & report generation	2
Date	20/11/2015	Date	24/11/2015		
Signature (Resid	Andrew Henderson	(Super	Cecilia Hz		

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Annual Progress Report Submission Form

Conferences, Congresses and Professional Meetings attended Log (Sheet D)

Resident: Andrew Henderson | Institution: University of Nottingham

Primary Supervisor: Jon Huxley | Date: 24/11/2015 | Year of Residency: Two

Date	Duration	Name of Meeting / Location
13/04/2014	3 days	Residents Workshop (Nottingham)
15/10/2015	2 days	British Cattle Veterinary Association (BCVA) Annual Congress
11/11/2015	1 day	British Mastitis Conference
24/11/2015	1 day	Milking machine and milk harvesting course - Taurus CPD

Date	24/11/2015	Date	24/11/2015
Signature (Resident)	Andrew Henderson	Signature (Supervisor)	

Annual Progress Report Submission Form

Presentations at Conferences, Congresses, and Professional Meetings Log (Sheet E)

Resident: Andrew Henderson | Institution: University of Nottingham

Primary Supervisor: Jon Huxley | Date: 20/11/2015 | Year of Residency: Two

Date & Duration	Name of the meeting / event location	Title, type and duration of the presentation
25/09/2015	Farm Animal Rounds - University of Nottingham	0.5 hrs - The prediction of intra-mammary infection status across the dry period
15/10/2015	British Cattle Veterinary Association (BCVA) Annual Congress	The prediction of cure of intra-mammary infection across the dry period from lifetime cow records, research presentation, 15 minutes
19/10/2015	Visitation from Melbourne Veterinary School, Sutton Bonington Campus University of Nottingham	The prediction of cure of intra-mammary infection across the dry period from lifetime cow records, research presentation, 15 minutes
14/10/2015	Interview, Sutton Bonington Campus University of Nottingham	What does an innovative veterinary school require in terms of teaching and research and what can I can contribute?; Interview; 15 minutes
11/11/2015	British Mastitis Conference - Sixways Conference Centre, Worcester	Poster presentation - The prediction of cure of intra-mammary infection across the dry period from lifetime cow records

Date	20/11/2015	Date	24/11/2015
Signature (Resident)	Andrew Henderson	Signature (Supervisor)	

Annual Progress Report Submission Form

Lectures and Seminars given Log (Sheet G)

Resident: Andrew Henderson

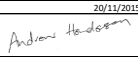
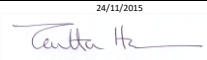
Institution: University of Nottingham

Primary Supervisor: Jon Huxley

Date: 20/11/2015

Year of Residency: Two

Date	Duration and Location	Type of event	Topic	Participants
21/01/2015	3 hours School of Veterinary Medicine and Science, University of Nottingham	Seminar	Body condition scoring & mobility scoring	Undergraduates × 5
05/02/2015	3 hours School of Veterinary Medicine and Science, University of Nottingham	Seminar	Body condition scoring & mobility scoring	Undergraduates × 5
17/02/2015	1 hour School of Veterinary Medicine and Science, University of Nottingham	Seminar	Haptic cow - the basics of rectal palpation and pregnancy diagnosis	2nd year undergraduates
18/02/2015	1.5 hours School of Veterinary Medicine and Science, University of Nottingham	Seminar	Haptic cow - the basics of rectal palpation and pregnancy diagnosis	4th year undergraduates
19/02/2015	3 hours School of Veterinary Medicine and Science, University of Nottingham	Seminar	Body condition scoring & mobility scoring	Undergraduates × 5
25/02/2015	2 hours School of Veterinary Medicine and Science, University of Nottingham	Seminar	Herd Health - Putting it into Practice	Undergraduates × 20
05/03/2015	3 hours School of Veterinary Medicine and Science, University of Nottingham	Seminar	Body condition scoring & mobility scoring	Undergraduates × 5
09/03/2015	6 hours School of Veterinary Medicine and Science, University of Nottingham	Seminar	Castrating & Dis-budding practical	Undergraduates × 20
13/03/2015	7 hours School of Veterinary Medicine and Science, University of Nottingham	Seminar	Castrating & Dis-budding practical	Undergraduates × 20
19/03/2015	3 hours School of Veterinary Medicine and Science, University of Nottingham	Seminar	Body condition scoring & mobility scoring	Undergraduates × 5
02/04/2015	3 hours School of Veterinary Medicine and Science, University of Nottingham	Seminar	Body condition scoring & mobility scoring	Undergraduates × 5
16/04/2015	3 hours School of Veterinary Medicine and Science, University of Nottingham	Seminar	Body condition scoring & mobility scoring	Undergraduates × 5
13/08/2015	5 hours School of Veterinary Medicine and Science, University of Nottingham	Seminar	Body condition scoring & mobility scoring	Undergraduates × 5
27/08/2015	4 hours School of Veterinary Medicine and Science, University of Nottingham	Seminar	Body condition scoring & mobility scoring	Undergraduates × 5
10/09/2015	3 hours School of Veterinary Medicine and Science, University of Nottingham	Seminar	Body condition scoring & mobility scoring	Undergraduates × 5
21/09/2015	3 hours School of Veterinary Medicine and Science, University of Nottingham	Seminar	Herd Health - Data Analysis	Undergraduates × 5
24/09/2015	2 hours School of Veterinary Medicine and Science, University of Nottingham	Seminar	Body condition scoring & mobility scoring	Undergraduates × 5
25/09/2015	0.5 hrs School of Veterinary Medicine and Science, University of Nottingham	Lecture	The prediction of intra-mammary infection status across the dry period	Postgraduates, Academic staff & Clinicians
05/10/2015	3 hours School of Veterinary Medicine and Science, University of Nottingham	Seminar	Herd Health - Data Analysis	Undergraduates × 3
08/10/2015	2 hours School of Veterinary Medicine and Science, University of Nottingham	Seminar	Body condition scoring & mobility scoring	Undergraduates × 5
12/10/2015	3 hours School of Veterinary Medicine and Science, University of Nottingham	Seminar	Introduction to Herd Health	Undergraduates × 5
22/10/2015	2 hours School of Veterinary Medicine and Science, University of Nottingham	Seminar	Body condition scoring & mobility scoring	Undergraduates × 5
28/10/2015	3 hours School of Veterinary Medicine and Science, University of Nottingham	Seminar	Introduction to Herd Health	Undergraduates × 5
29/10/2015	3 hours School of Veterinary Medicine and Science, University of Nottingham	Seminar	Handling of ruminants	Undergraduates × 50
16/11/2015	2 hours School of Veterinary Medicine and Science, University of Nottingham	Seminar	Interpretation of Johne's ELISA result	Undergraduates × 50
17/11/2015	2 hours School of Veterinary Medicine and Science, University of Nottingham	Seminar	Palpation of the bovine distal limb	Undergraduates × 50
19/11/2015	2 hours School of Veterinary Medicine and Science, University of Nottingham	Seminar	Body condition scoring & mobility scoring	Undergraduates × 5

Date	20/11/2015	Date	24/11/2015
Signature (Resident)		Signature (Supervisor)	

Annual Progress Report Submission Form

Lectures and Seminars attended Log (Sheet F)

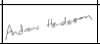
Resident: Andrew Henderson

Institution: University of Nottingham

Primary Supervisor: Jon Huxley

Date: 20/11/2015

Year of Residency: Two

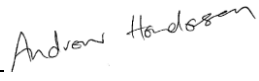
Date	Duration	Topic	Type of event / Location	Speaker	Participants
14/01/2015	1 day	Recent research update - lameness, mastitis, MAP, bTB, fertility	University of Nottingham - Dairy Herd Health Group	Various Postgraduate Researchers	Postgraduates, Academic staff & Clinicians
20/01/2015	6 hrs	Introduction to Microsoft Excel	IT skills - Jubilee Campus University of Nottingham	Tracy Hassall - Jones	Postgraduates
24/01/2015	1 hr	Dairy cow - Cash cow or sacred cow	Professorial Lecture - University of Nottingham	Professor Jon Huxley	Postgraduates, Academic staff & Clinicians
27/01/2015	1 hr	Feeding the contemporary dairy cow	Webinar - Dairy Co	Professor Liam Sinclair	Postgraduates, Academic staff & Clinicians
03/02/2015	3.5 hrs	Microsoft Excel - More Functions	IT skills - Jubilee Campus University of Nottingham	Tracy Hassall - Jones	Postgraduates
16/02/2015	1 hr	Multi - level modelling - Farm Maths Club	Seminar University of Nottingham	Dr Richard Emes	Postgraduates, Academic staff & Clinicians
18/02/2015	1 hr	Evaluation of the use of dry cow antibiotics in low somatic cellc count cows	Journal Club - critical appraisal of paper University of Nottingham	Dr Simon Archer	Postgraduates, Academic staff & Clinicians
18/02/2015	1 hr	Multi - level modelling	Statistics Club University of Nottingham	Dr Chris Hudson	Postgraduates, Academic staff & Clinicians
16/02/2015	1 hr	Bayesian statistical analysis	Population Health & Welfare Group University of Nottingham	Dr Simon Archer	Postgraduates, Academic staff & Clinicians
13/02/2015	3.5 hrs	Farm Animal Rounds - Various	Farm Animal Rounds - University of Nottingham	Various - Hettie Thomas, Prof John Huxley	Postgraduates, Academic staff & Clinicians
27/02/2015	3.5 hrs	Farm Animal Rounds - Various	Farm Animal Rounds - University of Nottingham	Various - John Remnant	Postgraduates, Academic staff & Clinicians
16/03/2015	0.3 hr	The economics of heifer rearing	Webinar - Dairy Co	Dr Alana Boulton	Various
16/03/2015	1 hr	Monitoring the transition period for health and fertility	Webinar - Dairy Co	Dr Stephen LeBlanc	Various
17/03/2015	0.5 hr	Transition Cow: The importance of BCS & concentrate feeding	Webinar - Dairy Co	Dr Ryan Law	Various
16/03/2015	1 hr	Latent Class Analysis - Multi - level modelling - Farm Maths Club	Seminar University of Nottingham	Professor Martin Green	Postgraduates, Academic staff & Clinicians
16/03/2015	1 hr	Physosocial reasons behind provision of veterinary services to UK sheep farmers	Seminar University of Nottingham	Camille Bellet	Postgraduates, Academic staff & Clinicians
04/09/2015	1hr	Are you making the most of genomics	Webinar - AHDB	Marco Winters	Postgraduates, Academic staff & Clinicians
02/09/2015	6.5 hrs	Bull Breeding Soundness Examination	Seminar - Devon: BCVA	Colin Penny	Clinicians
09/07/2015	1 day	Recycled manure bedding, housing design and UK dairy industry	University of Nottingham - Dairy Herd Health Group	Various academic staff & clinicians	Postgraduates, Academic staff & Clinicians
22/09/2015	1hr	Happy heifers - The Welsh heifer rearing project	Webinar - BCVA	Owen Atkinson	Postgraduates, Academic staff & Clinicians
25/09/2015	0.5 hr	Survival of first lactation heifers in UK dairy herds	Farm Animal Rounds - University of Nottingham	Ginny Sherwin	Postgraduates, Academic staff & Clinicians
29/09/2015	3 hrs	The use of selective dry cow therapy on Arla farms in the UK	Kegworth Conference Centre - Seminar	Duncan Williams	Veterinary surgeons
07/10/2015	1 hr	The geographies of epidemiology	Seminar University of Nottingham	Dr Gareth Enticott	Postgraduates, Academic staff & Clinicians
21/10/2015	1hr	Early embryonic development	Seminar University of Nottingham	Professor Pat Lonergan	Postgraduates, Academic staff & Clinicians
17/11/2015	1hr	Selective dry cow therapy	Webinar - The Webinar Vet	Peter Edmondson	Clinicians
Date	20/11/2015	Date	24/11/2015		
Signature (Resident)		Signature (Supervisor)			

Annual Progress Report Submission Form

Anicillary Topics Case Log - Pathology/Necropsies (Sheet C)

Resident: Andrew Henderson | Institution: University of Nottingham

Primary Supervisor: Jon Huxley | Date: 20/11/2015 | Year of Residency: Two

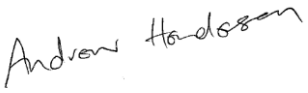
Date	Animal ID	Animal Category (species, type, sex, age)	Diagnosis	Activity of the resident	Supervision
22/12/2014		HF - Dairy foetus, 5 months	Abortion	Performed necropsy	3
26/01/2015		HF - Dairy foetus, 7 months	Abortion	Performed necropsy	3
26/01/2015		AAX - Beef heifer, 3 months	Pleuro-pneumonia	Performed necropsy	3
26/01/2015		AAX - Beef heifer, 5 months	Pleuro-pneumonia	Performed necropsy	3
26/01/2015		LIMX - Beef bull, 12 months	Suspect listerial encephalitis or lead poisoning	Performed necropsy	3
26/01/2015		HF - Dairy foetus, 5 months	Abortion	Performed necropsy	3
27/01/2015		HF - Dairy cow, 3rd lactation	Right displaced abomasum with volvulus	Helped to perform necropsy	5
27/01/2015		SIMX -Beef heifer, 2 months	Fibrinous-pleuropneumonia	Helped to perform necropsy	5
28/01/2015		LIMX - Beef foetus, 7.5 months	Abortion	Performed necropsy	3
28/01/2015		AAX - Beef foetus, 7.5 months	Abortion	Performed necropsy	3
28/01/2015		HF - Dairy calf, 4 weeks	Coccidiosis	Performed necropsy	1
28/01/2015		HF - Dairy calf, 6 weeks	Pleuro-pneumonia	Performed necropsy	3
29/01/2015		CHARX - Beef steer, 3 months	Pleuro-pneumonia	Performed necropsy	3
29/01/2015		SIMX - Beef heifer, 5 months	Mucosal disease	Performed necropsy	3
29/01/2015		AAX - Beef steer, 4 months	Cerebrocortical necrosis	Helped to perform necropsy	5
29/01/2015		HERX - Beef steer, 2 months	Torsion of the root of the mesentry	Performed necropsy	5
10/04/2015		LIMX - Dairy cross, 2 months	Bacterial meningitis	Performed necropsy	1
14/09/2015		HOL - Dairy calf, 1 week	Atresia coli	Helped to perform necropsy	5
15/09/2015		HOL - Dairy cow, 3rd lactation	Abomasal impaction	Observed necropsy	7
15/09/2015		HOL - Dairy cow, 1st lactation	Peritonitis	Observed necropsy	7
16/09/2015		HOL - Dairy cow, 4th lactation	Abomasal ulcer	Observed necropsy	7
29/10/2015		HOL - dairy calf, 4 weeks	Pneumonia	Helped to perform necropsy	5
	Date	20/11/2015	Date	24/11/2015	
	Signature (Resident)		Signature (Supervisor)		

Annual Progress Report Summary Sheet

Resident: Andrew Henderson | Institution: University of Nottingham

Primary Supervisor: Jon Huxley | Date: 20/11/2015 | Year Of Residency: Two

Training Element	Numbers
Individual clinical cases	100
Herd health cases	71
Ancillary topics - Pathology/Necropsies	22
Conferences, congresses and professional meetings attended	4
Presentations at conferences, congresses and professional meetings	5
Lectures and seminars attended	25
Lectures and seminars given	27

Date:	20/11/2015
Signature (Resident):	
Date:	24/11/2015
Signature (Supervisor):	

11.11.3 Year Three ECBHM Residency Case Log

Annual Progress Report Submission Form

Individual Clinical Case Log (Sheet A)

Resident: Andrew Henderson

Institution: University of Nottingham

Date: 19/02/2016

Primary Supervisor: Jon Huxley

Year of Residency: Three

Date	Patient ID	Patient Category (species, type, sex, age)	Diagnosis	Clinical activity of the resident	Supervision
02/12/2015	Green	Friesian, Dairy Heifer 1st lactation	Caesarean section	Obstetric surgery	2
03/12/2015	Hol	Holstein, Dairy Cow, 3rd lactation	Fractured femur	Clinical examination & ante-mortem inspection for casualty slaughter	2
04/12/2015	Adk	Holstein, Dairy	Traumatic reticulo-	Clinical examination, ultrasound scan of reticulum and treatment	2

		Heifer, 1st lactation	peritonitis		
04/12/2015	Adk	Holstein, Dairy Heifer, 1st lactation	Pneumonia	Clinical examination and treatment	2
04/12/2015	Adk	Holstein, Dairy Heifer, 1st lactation	Pneumonia	Clinical examination and treatment	2
07/12/2015	Fos	Holstein, Dairy Cow, 2nd lactation	Pyrexia of unknown origin	Clinical examination and treatment	2
07/12/2015	Nea	Belgian Blue Bull, 2 years old	? Fractured femur	Clinical examination & ante-mortem inspection for casualty slaughter	2
08/12/2015	Bay	Holstein, Dairy Cow, 3rd lactation	Left displaced abomasum	Right flank laparotomy & pyloropexy	2
08/12/2015	How	Saler, Beef Cow, 8th parity	Toxaemic clincial mastitis and milk fever	Clinical examination & treatment	2
09/12/2015	Hay	Holstein, Dairy Heifer, 1 year old	De-horn	Local/regional anaesthesia and horn removal	2

10/10/2015	Bac	Holstein, Dairy Cow, 2nd lactation	Pneumonia	Clincial examination, ultrasound scsan of lung field & treatment	2
11/10/2015	Adk	Holstein, Dairy Cow, 3rd lactation	Metritis	Clincial examination & treatment	2
12/12/2015	Smi	Friesian, Dairy Heifer 1st lactation	Calving - leg back	Epidural, correction and delivery	2
12/12/2015	Bea	Belgian Blue Cow, 3rd parity	Caesarean section	Obstetric surgery	2
13/12/2015	Aus	Friesian, Dairy Cow, 5th lactation	Milk fever	Clinical examination & treatment	2
14/12/2015	Adk	Holstein, Dairy Heifer, 1st lactation	Traumatic reticulo-peritonitis	Clinical examination & treatment	2
14/12/2015	Adk	Holstein, Dairy calves, 4 weeks old × 8	Pneumonia	Clinical examination & treatment	2
15/12/2015	May	Holstein, Dairy	Enteritis	Clinical examination & treatment	2

		Cow, 4th lactation			
21/12/2015	Bac	Holstein, Dairy Heifer, 1st lactation	Pneumonia	Clinical examination & treatment	2
22/12/2015	All	Holstein, Dairy Cow, 2nd lactation	Mastitis & metritis	Clinical examination & treatment	2
23/12/2015	Adk	Beef Cross Bulls (3 - 6 months) × 35	Castration	Surgical castration	2
29/12/2015	Bow	Holstein, Dairy Cow, 3rd lactation	Damaged tail	Tail amputation	2
30/12/2015	Feat	Belgian Blue Bull, 8 months old	Castration	Open surgical castration	2
01/01/2016	Great	Belgian Blue heifer	Calving	Examination and delivery	2
04/01/2016	War	Holstein dairy heifer, 10 weeks old	Pneumonia	Clinical examination & treatment	2
04/01/2016	War	Holstein dairy heifer	Pneumonia	Clinical examination & treatment	2

		, 6 weeks old			
05/01/2016	Bay	Holstein, dairy cow, 2nd lactation	Staphylococcal dermatitis of the udder	Clinical examination and treatment	2
05/01/2016	Bay	Holstein dairy heifer, 1st lactation	Excessive udder oedema	Clinical examination & treatment	2
05/01/2016	Bay	Holstein dairy heifer, 1 week old	Stomach tubing injury to oesophagus	Clinical examination & treatment	2
05/01/2016	All	Holstein dairy cow, 3rd lactation	Chronic suppurative pneumonia	Clinical examination, ultrasound scan of lung fields & euthanasia	2
10/01/2016	Haw	Holstein dairy cow, 2nd lactation	Toxic E. coli mastitis	Clinical examination & treatment (antimicrobials, NSAIDs, IVFT and oral fluids)	2
11/01/2016	Bir	Holstein dairy cow, 4th lactation	Ketosis	Clinical examination & treatment	2
12/01/2016	Brow	Holstein dairy heifer, 1 st	Fractured femur	Clinical examination & on farm emergency slaughter/ante-mortem inspection	2

		lactation			
12/01/2016	Brow	Holstein dairy cow, 5th lactation	Metritis	Clinical examination & treatment	2
12/01/2016	Brow	Holstein dairy cow, 3rd lactation	Metritis	Clinical examination & treatment	2
12/01/2016	Brow	Holstein dairy cow, 1st lactation	Metritis	Clinical examination & treatment	2
12/01/2016	Bay	Holstein dairy cow, 3rd lactation	Bilateral peroneal nerve paralysis	Clinical examination & on farm emergency slaughter/ante-mortem inspection	2
13/01/2016	Feat	AAX bull, 8 months old	Castration	Open surgical castration	2
13/01/2016	God	Holstein dairy cow, 2nd lactation	Traumatic reticulo-peritonitis	Clinical examination & treatment	2
14/01/2016	Bac	Holstein dairy cow, 4th lactation	White line abscess	Clinical examination & curative trim, block/NSAIDs	2
14/01/2016	Bac	Holstein dairy	Right displaced abomasu	Clinical examination & euthanasia	2

		cow, 2nd lactation	m with volvulus		
19/01/2016	Bay	Holstein dairy cow, 3rd lactation	Vagal indigestion	Clinical examination & treatment	2
20/01/2016	Sew	Montbelliarde dairy heifer	C - section	Obstetric surgery	2
20/01/2016	Dea	Hereford heifer calf, 4 months old	De-horn	De-horn	2
20/01/2016	Dea	Hereford heifer calf, 4 months old	De-horn	De-horn	2
22/01/2016	Dur	AAX bull, 8 months old	Bovine iritis	Clinical examination & treatment	2
25/01/2016	Dic	BBX, 8 months	De-horn	Dehorn	2
27/01/2016	Yat	Holstein dairy cow, 3rd lactation	Mastitis	Clinical examination & treatment	2
29/01/2016	Green	Holstein dairy heifer, 12 months	Lumpy jaw (Actinomyces bovis)	Clinical examination & treatment	2

29/01/2016	Adk	Holstein dairy cow, 1st lactation	Pneumonia	Clinical examination & treatment	2
29/01/2016	Adk	Holstein dairy cow, 3rd lactation	Metritis	Clinical examination & treatment	2
01/02/2016	War	Holstein dairy heifer, 2 months old	Pneumonia	Clinical examination & treatment	2
02/02/2016	Bay	Holstein dairy cow, 2nd lactation	Subclinical ketosis	Clinical examination & treatment	2
02/02/2016	Adk	Holstein dairy cow, 4th lactation	Right displaced abomasum with volvulus	Right flank laparotomy, deflation, de-rotation & pyloropexy	2
02/02/2016	All	Friesian dairy heifers, 3 weeks old	Pneumonia	Clinical examination & treatment	2
03/02/2016	Hay	Holstein dairy cow, 1st lactation	Pneumonia	Clinical examination & treatment	2

04/02/2016	Por	Limousin beef cow, 3rd parity	Uterine prolapse	Obstetric replacement	2
04/02/2016	Bac	Holstein dairy cow, 5th lactation	Left displaced abomasum	Right flank laparotomy & pyloropexy	2
05/02/2016	Sre	Holstein dairy cow, 2nd lactation	Retained foetal membranes	Clinical examination & treatment	2
05/02/2016	Aus	Friesian dairy cow, 6th lactation	Hypocalcaemia & mastitis	Clinical examination & treatment	2
05/02/2016	Par	Holstein dairy cow, 3rd lactation	Toxic E. coli mastitis	Clinical examination, treatment & oral fluids	2
05/02/2016	Par	Holstein dairy cow, 2nd lactation	Traumatic reticulo-peritonitis	Clinical examination & treatment	2
06/02/2016	God	Holstein dairy cow, 4th lactation	Toxic E. coli mastitis	Clinical examination, treatment, oral fluids and intravenous fluid therapy	2
06/02/2016	Gil	Holstein dairy	Infected stifle	Clinical examination & treatment	2

		heifer, 8 weeks			
06/02/2016	Adk	Holstein dairy cow, 1st lactation	Calving	Caesarean section	2
07/02/2016	Dea	Hereford bull, 18 months	Fractured metatarsal bone	Clinical examination & euthanasia	2
08/02/2016	Bac	Holstein dairy cow, 3rd lactation	Caecal dilatation	Clinical examination, exploratory laparotomy & deflation, oral fluids and intravenous fluid therapy	2
09/02/2016	Dil	Montbelliarde dairy cow, 3rd lactation	Johne's disease	Clinical examination & diagnostic testing	2
09/02/2016	Dow	Hereford cross cow, 2nd parity	Mastitis	Clinical examination & treatment	2
10/02/2016	Web	BBX beef steer, 16 months	Bovine iritis	Clinical examination & treatment	2
10/02/2016	Web	BBX beef steer, 16 months	Bovine iritis	Clinical examination & treatment	2

10/02/2016	Yat	Charolais beef steer, 10 months	Pneumonia	Clinical examination & treatment	2
10/02/2016	Fos	Holstein dairy cow, 3rd lactation	Left displaced abomasum	Right flank laparotomy & pyloropexy	2
10/02/2016	Whi	BB dairy cow, 1st lactation	Calving	Caesarean section	2
11/02/2016	Col	Hereford steer, 6 weeks	Bloat	Clinical examination & treatment	2
11/02/2016	Jarr	Friesian steer, 7 weeks	Infected navel	Clinical examination, sedation, lance, flush & treatment	2
12/02/2016	Adk	Holstein dairy cow, 4th lactation	Metritis & subclinical ketosis	Clinical examination & treatment	2
12/02/2016	Adk	Holstein dairy cow, 5th lactation	Pneumonia	Clinical examination & treatment	2
12/02/2016	Adk	Holstein dairy cow, 2nd lactation	Metritis	Clinical examination & treatment	2

16/02/2016	Bay	Holstein dairy cow, 3rd lactation	Metritis	Clinical examination & treatment	2
16/02/2016	Bay	Holstein dairy cow, 2nd lactation	Subclinical ketosis	Clinical examination & treatment	2
16/02/2016	Bee	Holstein dairy cow, 8th lactation	Toxic gangrenous mastitis	Clinical examination & euthanasia	2
17/02/2016	Nea	Belgian Blue Bull, 20 months	Physical Exam	Physical Exam	2
17/02/2016	Bay	Holstein dairy cow, 2nd lactation	Left displaced abomasum	Right flank laparotomy & pyloropexy	2
17/02/2016	Bas	Holstein dairy cow, 4th lactation	Calving	Obstetric delivery	2
18/02/2016	Bac	Holstein dairy cow, 3rd lactation	Traumatic reticulo-peritonitis	Clinical examination & treatment	2
19/02/2016	Fer	Holstein dairy	Left displaced	Right flank laparotomy & pyloropexy	2

		cow, 5th lactation	abomasum		
	Date	23/02/2016	Date	23/02/2016	
	Signature (Resident)				

Annual Progress Report Submission Form

Individual Clinical Case Log (Sheet B)

Resident: Andrew Henderson

Institution: University of Nottingham

Primary Supervisor: Jon Huxley

Date: 19/02/2016

Year of Residency: Three

Date	Farm ID	Farm type	Area or problem dealt with on farm	Activity of the Resident	Supervision
01/12/2015	Bow	Dairy Farm	Routine Fertility	Pregnancy Diagnosis, Management of non - bullers and Post natal checks	2
02/12/2015	Alder	Beef Suckler Farm	Routine Fertility	Pregnancy Diagnosis ×25	2
03/12/2015	Tay	Beef Suckler	Routine Fertility	Pregnancy Diagnosis ×50	2

		Farm			
04/12/2015	Jar	Dairy Farm	Routine Fertility	Post Natal Checks	2
04/12/2015	Jar	Beef Suckler Farm	Routine Fertility	Pregnancy Diagnosis × 41	2
04/12/2015	Adk	Dairy Farm	Routine Fertility	Pregnancy diagnosis, post natal check and oestrus not observed	2
09/12/2015	Hay	Dairy Farm	Routine Fertility	Pregnancy diagnosis, post natal check and oestrus not observed	2
09/12/2015	Bro	Dairy Farm	Routine Fertility	Pregnancy diagnosis, post natal check and oestrus not observed	2
10/12/2015	Bac	Dairy Farm	Routine Fertility	Pregnancy diagnosis, post natal check and oestrus not observed	2
11/12/2015	Adk	Dairy Farm	Routine Fertility	Pregnancy diagnosis, post natal check and oestrus not observed	2
16/12/2015	Oul	Dairy Farm	Bovine respiratory disease outbreak in youngstock	Discussion and investigation (total	2

				protein sampling, bvd diagnostics, ventilation assessments)	
18/12/2015	Jar	Dairy Farm	Routine Fertility	Post Natal Checks	2
18/12/2015	Adk	Dairy Farm	Routine Fertility	Pregnancy diagnosis, post natal check and oestrus not observed	2
21/12/2015	War	Dairy Farm	Routine Fertility	Pregnancy Diagnosis	2
22/12/2015	Goo	Dairy Farm	Routine Fertility	Pregnancy diagnosis, post natal check and oestrus not observed	2
23/12/2015	Adk	Dairy Farm	Training	Training farm staff to body condition and mobility score herd	2
24/12/2015	Bac	Dairy Farm	Routine Fertility & herd health discussion	Pregnancy diagnosis, post natal check, oestrus not observed & discuss transition cow management	2
29/12/	Bow	Dairy	Routine Fertility	Pregnancy diagnosis,	2

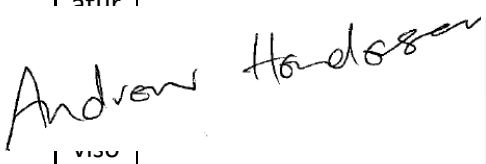
2015		Farm		post natal check and oestrus not observed	
30/12/2015	Adk	Dairy Farm	Routine Fertility & herd health discussion	Pregnancy diagnosis, post natal check, oestrus not observed & herd health discussion on mobility score results and lameness prevalence	2
31/12/2015	Bac	Dairy Farm	Routine Fertility & herd health discussion	Pregnancy diagnosis, oestrus not observed, post natal checks and discussion re increase in clinical mastitis cases	2
04/01/2016	War	Dairy Farm	Routine Fertility	Pregnancy diagnosis	2
05/01/2016	Bay	Dairy Farm	Routine Fertility	Post-natal Checks	2
06/01/2016	Sim	Beef Suckler Farm	Routine Fertility	Pregnancy diagnosis	2

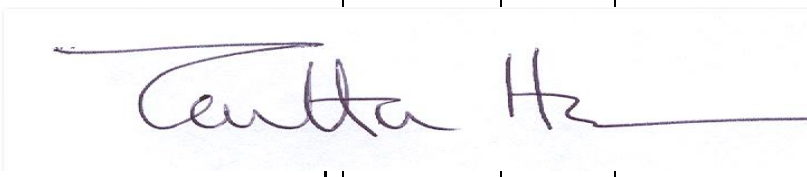
08/01/2016	Adk	Dairy Farm	Routine Fertility & herd health discussion	Pregnancy diagnosis, oestrus not observed, post natal checks and discussion re improvements in dry cow diet	2
14/01/2016	Bac	Dairy Farm	Routine Fertility	Pregnancy diagnosis, post natal check and oestrus not observed	2
15/01/2016	Adk	Dairy Farm	Routine Fertility	Pregnancy diagnosis, post natal check and oestrus not observed	2
18/01/2016	Mor	Dairy Farm	Routine Fertility	Pregnancy diagnosis, post natal check and oestrus not observed	2
18/01/2016	Bow	Dairy Farm	Routine Fertility	Pregnancy diagnosis	2
19/01/2016	Bay	Dairy Farm	Routine Fertility	Post natal checks	2
19/01/2016	Good	Dairy Farm	Routine Fertility	Pregnancy diagnosis, post natal check and oestrus not observed	2
20/01/	Dea	Beef	Routine Fertility	Pregnancy diagnosis	2

2016		Suckler Farm			
21/01/2016	Bac	Dairy Farm	Routine Fertility	Pregnancy diagnosis, post natal check and oestrus not observed	2
26/01/2016	Bow	Dairy Farm	Routine Fertility	Pregnancy diagnosis, post natal check and oestrus not observed	2
27/01/2016	Ada	Dairy Farm	Routine Fertility	Pregnancy diagnosis, post natal check and oestrus not observed	2
29/01/2016	Adk	Dairy Farm	Routine Fertility	Pregnancy diagnosis, post natal check and oestrus not observed	2
01/02/2016	War	Dairy Farm	Routine Fertility	Pregnancy diagnosis	2
02/02/2016	Bay	Dairy Farm	Routine Fertility	Pregnancy diagnosis, post natal check and oestrus not observed	2
02/02/2016	All	Dairy Farm	Routine Fertility	Pregnancy diagnosis, post natal check and oestrus not observed	2

03/02/2016	Hay	Dairy Farm	Routine Fertility	Pregnancy diagnosis, post natal check and oestrus not observed	2
09/02/2016	Dil	Dairy Farm	Routine Fertility	Pregnancy diagnosis, post natal check and oestrus not observed	2
09/02/2016	Dil	Dairy Farm	Routine Fertility	Pregnancy diagnosis, post natal check and oestrus not observed	2
12/02/2016	Jarr	Dairy Farm	Routine Fertility	Pregnancy diagnosis	2
15/02/2016	Mor	Dairy Farm	Routine Fertility	Pregnancy diagnosis, post natal check and oestrus not observed	2
16/02/2016	Bay	Dairy Farm	Routine Fertility	Pregnancy diagnosis, post natal check and oestrus not observed	2
17/02/2016	Hay	Dairy Farm	Routine Fertility	Pregnancy diagnosis, post natal check and oestrus not observed	2
18/02/2016	Bac	Dairy Farm	Routine Fertility & herd health discussion	Pregnancy diagnosis, oestrus not observed,	2

				post natal checks and discussion re increase in clinical mastitis cases	

Date	23/02/2016	Date	23/02/2016		
Signature (Resident)		Signatur			
		r)			



Annual Progress Report Submission Form

Conferences, Congresses and Professional Meetings attended Log (Sheet D)

Resident: Andrew Henderson | Institution: University of Nottingham

Primary Supervisor: Jon Huxley | Date: 19/02/2016 | Year of Residency: Three

Date	Duration	Name of Meeting / Location
14/12/2015	20 minutes	HIPRA Histophilus vaccination; Scarsdale Veterinary Group, Derby
26/01/2016	70 minutes	Tri-plate on farm culture system; Speaker - Erin Royster; SVMS, Sutton Bonington Campus, University of Nottingham
09/12/2015	60 minutes	Farm post-mortem; Speaker - Ben Strugnell; Online webinar with AHDB
25/01/2016	20 minutes	Calf Health; MSD Discussion; Scarsdale Veterinary Group, Derby

Date	23/02/2016	Date	23/02/2016
Signature (Resident)	Andrew Henderson	Signature (Supervisor)	

Annual Progress Report Submission Form

Presentations at Conferences, Congresses, and Professional Meetings Log (Sheet E)

Resident: Andrew Henderson | Institution: University of Nottingham

Primary Supervisor: Jon Huxley | Date: 19/02/2016 | Year of Residency: Three

Date & Duration	Name of the meeting / event location	Title, type and duration of the presentation
15/12/2015	Postgraduate Presentation Day, Sutton Bonington Campus University of Nottingham	The prediction of cure of intra-mammary infection across the dry period from lifetime cow records, research presentation, 45 minutes

Date	23/02/2016	Date	23/02/2016
Signature (Resident)	Andrew Henderson	Signature (Supervisor)	

Lectures and Seminars given Log (Sheet G)

Resident: Andrew Henderson

Institution: University of Nottingham

Primary Supervisor: Jon Huxley

Date: 19/02/2016

Year of Residency: Three

Date	Duration and Location	Type of event	Topic	Participants
22/12/2015	60 minutes; Scarsdale Veterinary Group, Markeaton, Derby	Seminar	MAP	5th Year Undergraduates
17/02/2016	60 minutes; Scarsdale Veterinary Group, Markeaton, Derby	Seminar	Using Total Vet to interpret farm data and performance	5th Year Undergraduates

Date	23/02/2016	Date	23/02/2016
Signature (Resident)	[signature]	Signature (Supervisor)	[signature]

Annual Progress Report Submission Form

Lectures and Seminars attended Log (Sheet F)

Resident: Andrew Henderson

Institution: University of Nottingham

Primary Supervisor: Jon Huxley

Date: 19/02/2016

Year of Residency: Three

Date	Duration	Topic	Type of event / Location	Speaker	Participants
14/01/2015	1 day	Recent research update - lameness, mastitis, MAP, bTB, fertility	Seminar, University of Nottingham - Dairy Herd Health Group	Various Postgraduate Researchers	Postgraduates, Academic staff & Clinicians
14/12/2015	20 minutes	HIPRA Histophilus vaccination	Seminar, Scarsdale Veterinary Group, Derby	HIPRA Vet	Clinicians
26/01/2016	70 minutes	Tri-plate on farm culture system	Seminar, SVMS, Sutton Bonington Campus, University of Nottingham	Erin Royster	Postgraduates, Academic staff, Clinicians, Farmers & consultants
09/12/2015	60 minutes	Farm post-mortem	Online webinar	Ben Strugnell	Postgraduates, Academic staff & Clinicians
25/01/2016	20 minutes	MSD Calf Health	Seminar, Scarsdale Veterinary Group, Derby	Paul Williams & Steve Press	Clinicians
24/02/2016	60 minutes	Bovine respiratory disease post-mortems	Seminar, Derby	Ben Strugnell	Clinicians

Date	23/02/2016	Date	23/02/2016
Signature (Resident)	[signature]	Signature (Supervisor)	[signature]

Annual Progress Report Submission Form

Anicillary Topics Case Log - Pathology/Necropsies (Sheet C)

Resident: Andrew Henderson | Institution: University of Nottingham

Primary Supervisor: Jon Huxley | Date: 19/02/2016 | Year of Residency: Three

Date	Animal ID	Animal Category (species, type, sex, age)	Diagnosis	Activity of the resident	Supervision
07/02/2016		Bovine, calf, heifer, 5 weeks	Pneumonia	Assisted with necropsy	2
03/02/2016		Bovine, foetus, 5 months	Abortion	Assisted with necropsy	1

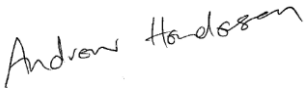
	Date	23/02/2016	Date	23/02/2016
	Signature (Resident)	Andrew Henderson	Signature (Supervisor)	

Annual Progress Report Summary Sheet

Resident: Andrew Henderson | Institution: University of Nottingham

Primary Supervisor: Jon Huxley | Date: 19/02/2016 | Year Of Residency: Three

Training Element	Numbers
Individual clinical cases	87
Herd health cases	46
Ancillary topics - Pathology/Necropsies	2
Conferences, congresses and professional meetings attended	4
Presentations at conferences, congresses and professional meetings	1
Lectures and seminars attended	6
Lectures and seminars given	2

Date:	23/02/2016
Signature (Resident):	
Date:	23/02/2016
Signature (Supervisor):	