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BRITISH CATTLE VETERINARY ASSOCIATION

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BRITISH MASTITIS CONFERENCE

Topics:

➢ **Diagnostic testing of mastitis**
➢ **To treat or not to treat?**
➢ **Research updates**
➢ **Challenges of small-scale direct selling**
➢ **Managing Outcomes. What does the data show?**
➢ **AHDB Mastitis Control Plan Case Study**

**Wednesday 10th November 2021
Pitchview Suite, Worcester Rugby Club
Sixways Stadium, Warriors Way,
Worcester, Worcestershire, WR3 8ZE**

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GENERAL INFORMATION

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CHAIRMAN'S INTRODUCTION

Welcome to the 2021 British Mastitis Conference, which returns to Sixways after the necessity of a Virtual event last year.

The Organising Committee has again worked to bring together a group of speakers, that we believe will provide thought provoking and stimulating presentations. As usual we have strived to balance the latest research with practical presentations with clear take home messages. Although last year´s Virtual format was highly successful, the overall consensus in the feedback was a return, as soon as practical and safe, to the traditional style, allowing for networking and discussions.

The first paper reviews diagnostic testing of mastitis and will be followed by a paper on the theme of 'To treat or not to Treat'. We will then have a short break for tea and coffee with time for delegates to look at the posters and ask questions of the presenters.

Building on the previous success, again endorsed by delegates in 2020, we have selected four posters from the Knowledge Transfer section for oral presentation. The four papers are followed by an opportunity for delegates to debate with each of the presenters.

After lunch we look at the challenge of setting up a small-scale direct supply business. This is followed by a paper on Managing outcomes – what does the data show. The final paper at BMC 2021 will again be an AHDB Mastitis Control Plan case study, which will look at an environment lactation pattern in a robotic milking herd.

This year sees another varied selection of high-quality poster submissions – all targeting improvement in udder health and overall milk quality. I urge you all to make time to review the posters and speak with the authors. Many of you know that the presenters put a great deal of effort into providing the abstracts and preparing and presenting their posters. So please do read their work and vote.

We endeavour to find you the best speakers with the most relevant (and latest) information. This is only achievable thanks to the generous support of all our sponsors. This year our sponsors are: Vetoquinol (Platinum), FullwoodPacko (Platinum), Hipra (Gold), MSD Animal Health (Gold), ADF Milking Limited (Gold), Norbrook (Silver), Boerhinger Ingelheim (Silver), milkrite | InterPuls (Silver), Ambic (Bronze) and DeLaval (Bronze). AHDB are sponsors of the Poster Competition.

As always, the event could not happen without able administration, provided by Karen Hobbs and Anne Sealey at *The* Dairy Group.

Finally, thank you for attending and supporting the conference. I trust you will have an enjoyable and worthwhile day and we hope to see you at our 34th BMC in 2022.

Ian Ohnstad, British Mastitis Conference Chairperson
The Dairy Group

TIMETABLE of EVENTS

08:45	ARRIVE / REGISTRATION / COFFEE & TEA AND POSTER DISPLAY	
09:45	CHAIRMAN'S INTRODUCTION	**Ian Ohnstad** *The* Dairy Group, UK

Session One

09:55	Review of diagnostic testing of mastitis.	**Chris Davison** University of Strathclyde UK
10:30	To treat or not to treat?	**Ian Glover** QMMS, UK

11:05	COFFEE and POSTERS	

Research updates (also presented as posters)

11:40	The impact of using teat seal only at dry-off on SCC and infection levels in the following lactation on 5 Irish commercial herds.	**Elizabeth Berry** BCVA, UK **Clare Clabby** Teagasc, Ireland
12.00	Online training for advisers to support udder health improvement through the QuarterPro initiative.	**Rachel Hayton** British Cattle Veterinary Association, UK
12:20	Survival of *Streptococcus uberis* on bedding substrates.	**Ginny Sherwin** University of Nottingham, UK
12:40	Descriptive study of Bactoscan failures on UK dairy farms (2010-2020).	**Al Manning** QMMS, UK

13:00	LUNCH and POSTERS	
14:10	WELCOME BACK AND VOTING ON POSTERS	

Session Three

14.15	The challenges of setting up a small-scale direct supply business.	**Brian Pocknee** DHC, Spain **Rachel Risdon** Greenhills Farming, UK
14.50	Managing Outcomes: What does the data show?	**Chris Hudson** University of Nottingham, UK
15.25	AHDB Mastitis Control Plan case study: Environmental lactation pattern in a robotic milking herd.	**Ellie Button** Howells Veterinary Services Ltd, UK

16:00	POSTER AWARD	
16:05	CLOSE	

Titles of Papers and Presenters

Scientific programme

Titles of Posters and Authors

Poster abstracts – presented at the Technology Transfer Session
(presenting author underlined):

Poster abstracts – also as an oral presentation in the Research Updates session
(presenting author underlined)

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NMC

A global organization for mastitis control and milk quality

National Mastitis Council is a professional organization that promotes research and provides information to the dairy industry to help reduce mastitis and enhance milk quality. For more than 50 years, NMC has distinguished itself internationally as a leader in meeting those objectives.

What does NMC do?

- Provides a forum for the global exchange of information on mastitis and milk quality
- Publishes educational materials, including books and brochures
- Establishes guidelines for mastitis control and milking management practices
- Monitors technological and regulatory developments relating to udder health, milk quality and milk safety
- Conducts meetings and workshops, providing educational opportunities for all segments of the dairy industry
- Funds the NMC Scholars program

Who are the members of NMC?

NMC membership is comprised of people from more than 40 countries, representing a wide range of dairy professionals who share an interest in milk quality and mastitis control. These people include veterinarians, milk quality consultants, dairy producers, university researchers and extension specialists, milk procurement field staff, equipment and supply representatives, regulatory officials and students.

What can NMC do for you?

The continued pressure to ensure milk safety and improve milk quality, as well as the need to increase production efficiency, requires greater team effort among producers, veterinarians and other dairy professionals. Each team member plays a key role in developing successful mastitis control programs. NMC can serve as your resource for information related to udder health, milking management, milk quality and milk safety.

Why join NMC?

- To receive the latest technical and applied information on udder health, milking management and milk quality
- To provide leadership on milk quality issues within the industry
- To participate and learn about mastitis and milk quality developments at NMC meetings
- To establish valuable industry contacts
- To support education and research efforts that help raise awareness and understanding of milk quality issues

NMC membership benefits

- NMC annual meeting and regional meeting proceedings, which contain all of the papers and posters presented at the meetings
- The NMC electronic newsletter addresses the latest information on udder health, milking management and milk quality
- Access to the "members-only" section of the NMC website, which includes the NMC Proceedings Library, NMC newsletter archives and NMC membership directory
- Opportunities to network with other dairy professionals concerned with milk quality, udder health and mastitis prevention, control and treatment

Working together

Since 1961, NMC has coordinated research and educational efforts to help control the losses associated with mastitis. By bringing together all
segments of the industry, a strong and successful organization has been created to enhance the quality of milk and dairy products. NMC welcomes your active participation and support. Please visit the NMC website for additional information and resources.

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PAPERS

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REVIEW OF DIAGNOSTIC TESTING OF MASTITIS

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SUMMARY

Mastitis is one of the most prevalent diseases in modern dairy farming. It has significant impacts both on the health of the animal, and on cost to the farm. Farm management practices can have a significant impact on control and treatment of mastitis (4), however there is no perfect solution.

With tight operating margins comes increasing farm size *without* a matching increase in on-farm labour, leading to increased use of automation. Traditional methods, such as Somatic Cell Count or enzymatic analysis, don't scale well to these changes in farm practice. No method is able to be considered a gold standard, either due to cost, sensitivity, ease of application, ability to detect sub-clinical mastitis.

INTRODUCTION

Mastitis is one of the most prevalent diseases in modern dairy farming. It is estimated to cost the UK dairy industry upwards of £170Million GBP annually (14), through dumping of milk not fit for consumption and cost of medical treatments. There is also a potential reduction in the productive capacity of the animal. The estimate for worldwide impact is over £14Billion(13).

Farm management practices can have a significant impact in control and treatment of mastitis, however farms are becoming increasingly consolidated in order to optimise production processes. This results in herdsmen managing increasingly large herds. For day to day operations, this can allow herdsmen to eliminate several man-hours per day, however it does imply that the herdsman is spending less time interacting with the animals and thus less likely to catch the onset of illness.

TRADITIONAL METHODS

Somatic Cell Counting (SCC)

Getting numbers that reflect the variety of dairy farm setups, both in the UK and internationally, is difficult. However, the most common method is some variant of Somatic Cell Counting (SCC)(2). Somatic cell counting is more beneficial in cases of acute mastitis, where it is clear that intervention is required. It is more limited in detecting sub-acute clinical mastitis, where there are no readily observable signs to indicate declining health of the

animal, or in change of milk composition. Some of these sub-acute cases may pass without incident, however a lasting question remains of whether it has impacted the productive capacity of that animal in the long-term. Should intervention of some sort still be provided?

Somatic Cell Counts are typically based on an enzymatic reaction, where the tests are comparatively cheap and fast, and estimates of SCC via either DNA staining or breaking down somatic cells through a detergent and analysing the reaction to determine SCC.

The California Mastitis Test (CMT) (2) is such a detergent approach. The test breaks down the somatic cells, clotting the milk, with a resultant viscosity that is proportional to the somatic cell count. These are cheap and easy to apply, but it can be difficult to accurately assess the viscosity; interpretation of the results can vary depending on who is assessing the test, rather than being an objective measure. With such an insensitive approach, do we err on the side of caution—treating potentially minor cases unnecessarily--or do we judge favourably and potentially allow a case of mastitis to set in?

Enzymatic Activity

Enzymatic approaches look for proxies in the milk that typically occur during mastitis (NBGase and lactate dehydrogenase) (2). The main disadvantage of these is that they are typically laboratory-based, so while they are effective for detecting mastitis, they are not particularly useful for large-scale farming systems where the latency between sampling and response makes them unsuitable for spot-sampling. This could be alleviated with a continual sampling and analysis approach, but that would greatly increase expense.

Electrical Conductivity of Milk / Automatic Milking Systems

With increased utilisation of Automatic Milking Systems (AMS), it is now possible to assess the milk of each individual cow during milking, potentially down to the quarter level. This gives insight into the fat, protein, and lactose content of the milk, but also (somewhat as a side-effect of the sensor methodology), these systems also often provide milk conductivity. Inflammation can be detected from this electrical conductivity as the inflammation causes an increase in ions such as sodium, potassium, and calcium (10). As these are built-in to the AMS, no additional equipment is needed, and the systems can be programmed to automatically provide alerts when the conductivity is out of an acceptable range, however factors other than mastitis can cause a change in electrical conductivity, meaning that it's not a particularly specific measure.

NOVEL APPROACHES

Lateral Flow Tests

An ongoing InnovateUK project (1) is developing a lateral flow test that detects mastitis and identifies the specific bacteria present, which will assist in deciding which antimicrobial treatment to apply for best effect. Details are sparse at the moment, however the project should be in the final stages and thus it is hoped that dissemination will follow in the coming months.

Combination of behaviour collar, EC, and milk constituents

Rather than specifically targeting mastitis, one approach may be simply to take advantage of other sensors that can provide insight into animal welfare, giving the herdsman an early warning.

Within the CowHealth and IoF2020 projects (12), we combined data from the AfiCollar(3) behaviour monitoring collar system and Fullwood Merlin(7) Automatic Milking Systems, to determine if the combination of systems could prove beneficial in the detection and treatment of welfare events. Mastitis was not a specific target at the onset of the project, but with the high prevalence of mastitis in most dairy herds, it presented itself as a natural target.

Figure 1 below shows information presented to the farmer for monitoring herd fertility. The activity level in yellow is analysed to provide an indicator of oestrus, which aligns with a change in behaviour exhibited in the green (eating) and blue (rumination) traces.

Figure 1   Fertility management from a behavioural monitoring collar
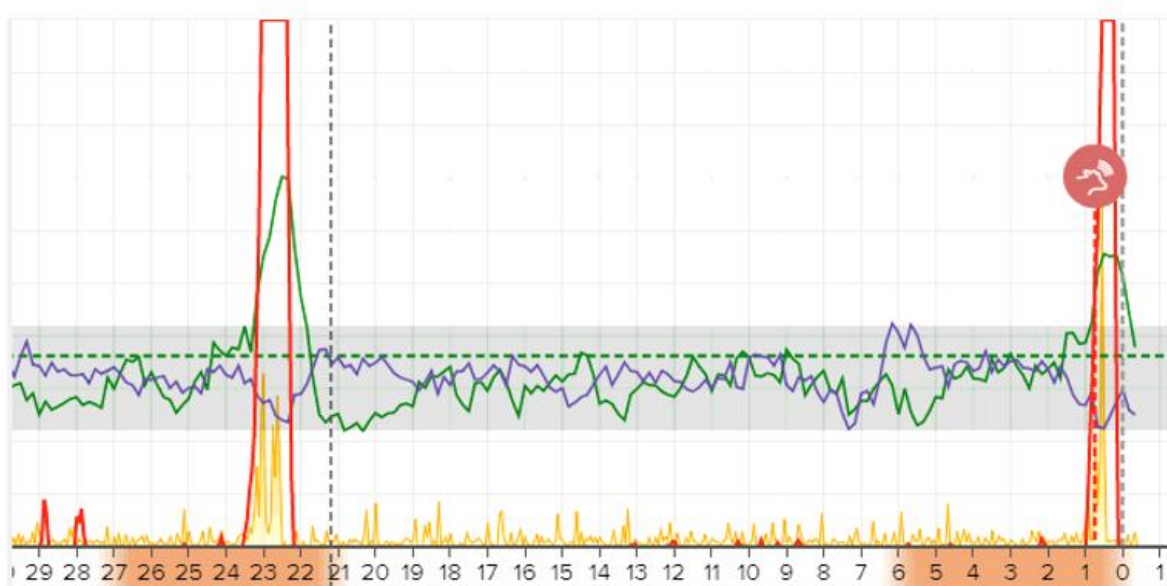
We can identify potential welfare events by noting when the eating and rumination patterns both drop (in reference to the individual animals' own history). Figure 2 shows such a case, where the rumination and eating behaviours both show a drop in over 30% compared to the historical average. The collar system only alerts to a welfare event, and in this case the farmer has annotated the event as being due to mastitis (diagnosed elsewhere).

Figure 2   Health alerts from a behavioural monitoring collar, with farmer's annotation of mastitis
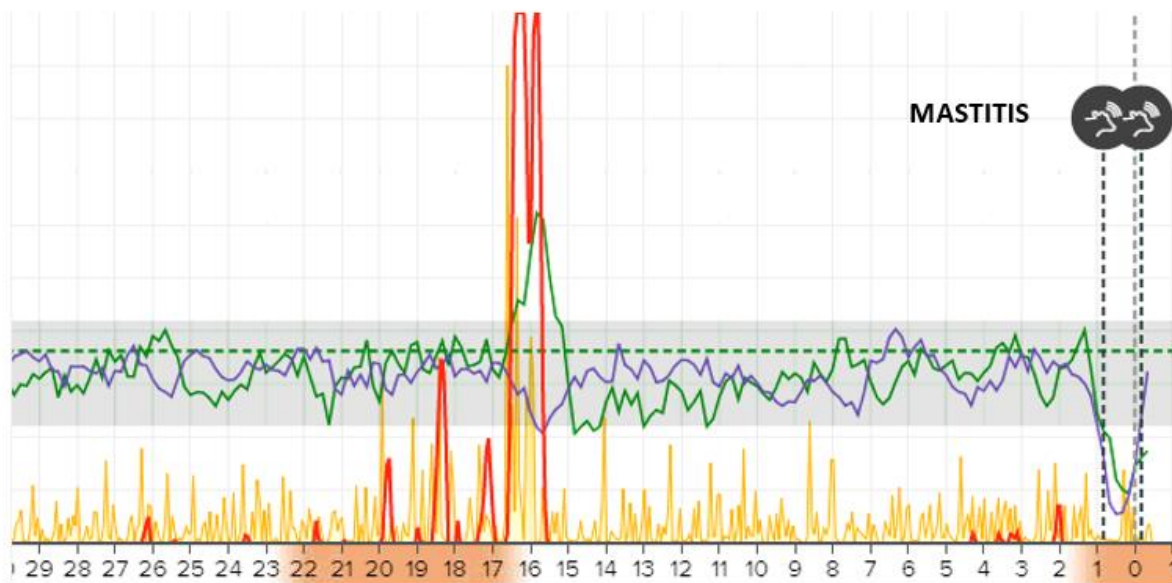
Considered alone, the collar can provide indication that something is potentially wrong with the animal. However, it lacks disease specificity, so cannot directly be used to instigate treatment. Figure 3 shows the Electrical Conductivity of each quarter of the udder during a separate mastitis event. It can be clearly seen that the right rear (rr) quarter exhibits a significant rise in conductivity (+50%) beginning 2 days prior to the farmers' diagnosis.

Figure 3   Rise in conductivity of one quarter of the udder several days before a mastitis event
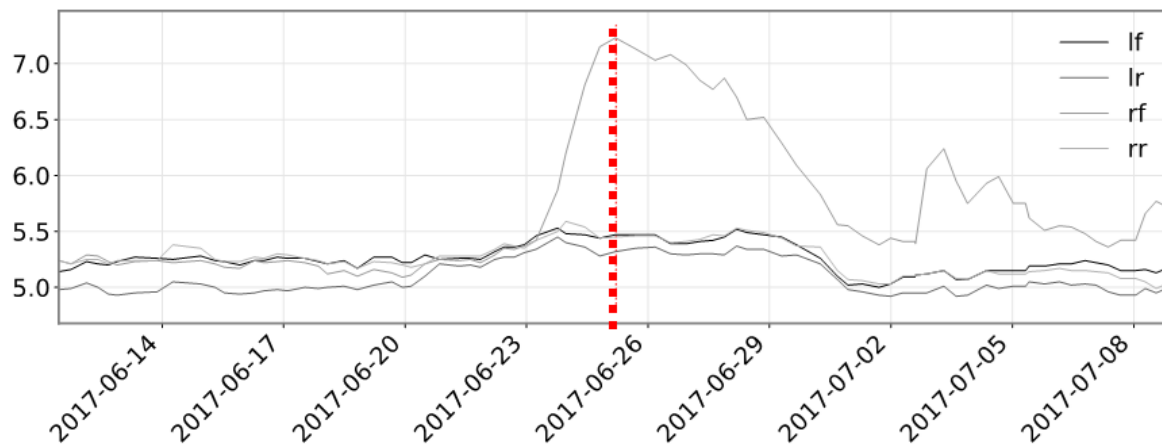
The AMS provider also suggested considering both lactose and fat:protein ratio as potential indicators. Mastitis damages the epithelial cells, which causes a decrease in the concentration of lactose in the milk (Figure 4).

Figure 4   Lactose and Fat:Protein ratio of the milk around a mastitis event
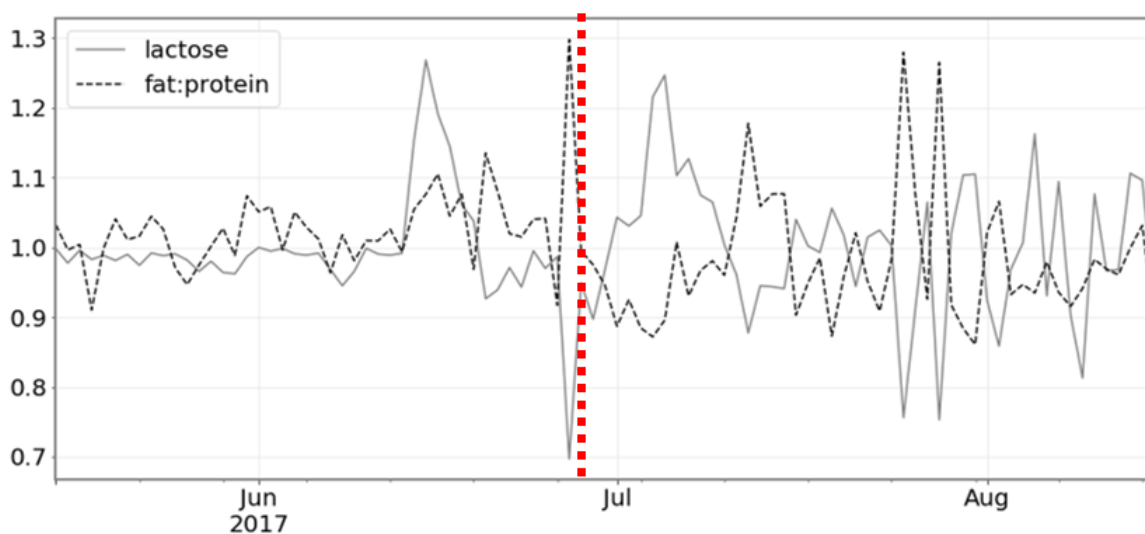
There has been little research on the relation between mastitis and fat content in the milk, with the literature often providing contradictory conclusions. In this research, the AMS provider also suggested an alert threshold of 4.5% milk fat (a heuristic from their industry experience rather than research trials). In Figure 5, we can see the combined output of both behaviour collar and AMS. The collar alerts a drop in eating and a rise in conductivity a day prior to the farmer's diagnosis, however the drop in rumination was not acute enough to provide an alert. The fat rose above the specified threshold on the day of detection. Figure 6 shows another mastitis event; in this instance, rumination and eating alert prior to the farmer's diagnosis, however the fat and

conductivity alerts are raised either on the same day, or after the farmers' diagnosis. As with the literature, fat proved to be inconsistent. It is susceptible to many outside factors, such as how recently an animal ate before attending the AMS.

Figure 5   Behavioural collar, milk conductivity, and indication of high milk fat around a mastitis event
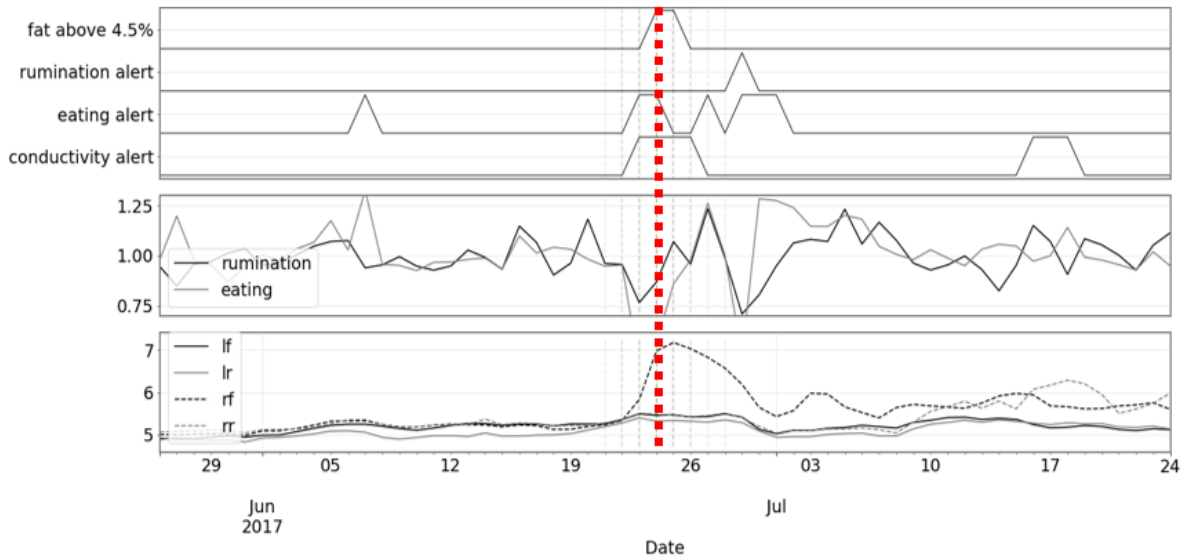
Figure 6   Behavioural collar, milk conductivity, and indication of high milk fat around mastitis event 2
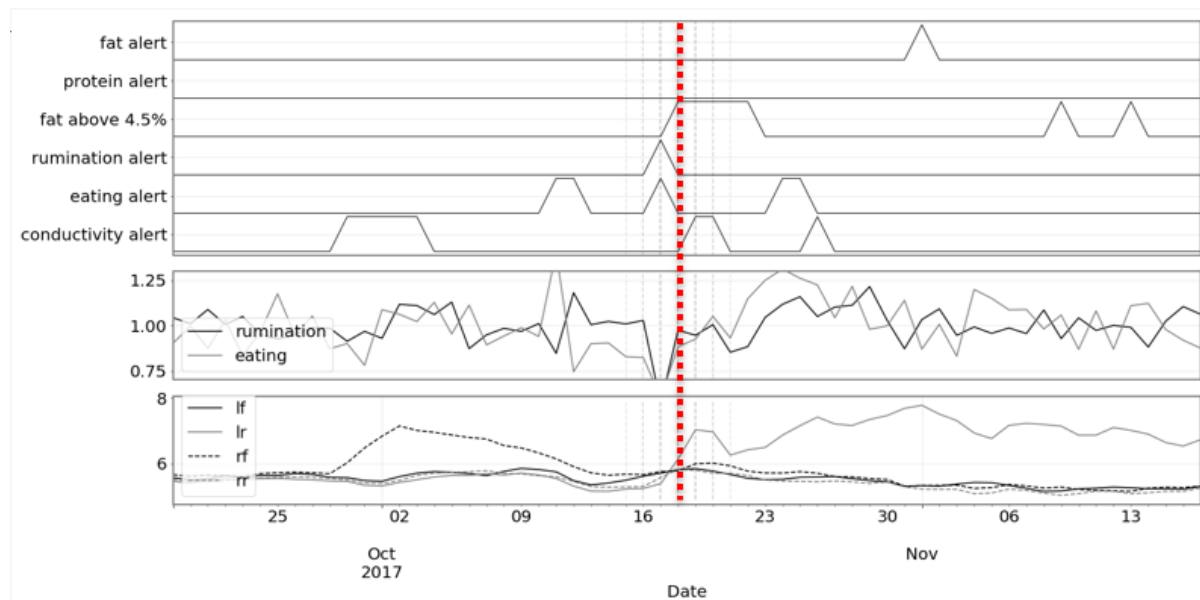
The predictive ability of the Behaviour Collar+AMS system is reported in Table 1. Data was captured from Weatherup Farm (Cowdenbeath, Scotland), over an 18 month period. 285 cows (HF) were collared, with around 200 in milk at any one period. There were 4 Fullwood Merlin milking robots. Over this 18 month period, 71 mastitis events were diagnosed on-farm.

6

Table 1 Predictive Ability of Collar+AMS Mastitis Detection, compared to farmers' on-farm diagnosis

Variable	Before	Before or Equal	After
Rumination	68%	84%	84%
Eating	71%	94%	95%
EC Quarter Rise	26%	49%	63%
Fat > 4.5%	23%	68%	78%

We can observe that the behaviour collar is quite sensitive to changes in cattle welfare, and in 70% of cases provides an alert *before* the farmer identified a case of mastitis. Electrical conductivity in this instance did not show high sensitivity; only half of all mastitis events were caught at least in time with the farmer. Fat above a heuristic threshold showed reasonable performance, with the caveat that it also frequently provided alerts without any matching welfare event diagnosis. This suggests that these approaches are insufficient on their own to be used as the sole source of truth, however if these systems are already in use on farm, they could be used as supporting alerts to reinforce or suppress future alerts and thus encourage or discourage intervention.

After the reported data was captured, the farmer applied a lime bedding treatment, which significantly reduced the prevalence of mastitis on the farm.

DISCUSSION / CONCLUSIONS

There is no gold-standard. There is no method that catches all instances of mastitis. Trade-offs must be made in terms of ease of testing, cost of testing, and impact on the animal. We cannot rely on Automatic Milking Systems as that limits traditional parlours. We cannot assume collar systems are prevalent. We cannot broadly apply SCC or enzyme tests as that would be both time and cost prohibitive, as well as missing sub-acute mastitis.

In my opinion, the most suitable approach is multi-faceted, using whatever data we have access to. The difficulty in that is farm equipment providers tend to want to stay siloed; they don't want to give a potential competitor a foothold, even if it's not an area they are currently active in. In order for a multi-faceted approach to be feasible, the systems must be able to talk to each other, or at least must be able to export data so that future researchers and engineers can build systems that aggregate data from multiple platforms. This has the added benefit of further reducing the burden on the herdsman; they could have one unified system to check, rather than having to gather information from 3 or 4 separate systems. We have attempted such an

endeavour, utilising the GlasData platform (8), however limitations on the export capabilities meant that while analysis could be performed on the combined data streams, we couldn't provide an entirely unified platform, thus we were simply providing an additional interface for a farmer to monitor.

When we consider that some of the methods covered here are not specific enough to directly identify mastitis, it's not advisable to advocate for automated intervention, particularly where it has cost to either the farmer or the animal's wellbeing. However, are there interventions such as stripping that could be carried out automatically? In the case of the aforementioned CowHealth project, one of the most beneficial interventions was simply a lime bedding treatment, which drastically reduced the incidence of mastitis on the farm.

What is the solution? Regulation? There are ongoing discussions around right-to-repair, particularly in the US with regards to farmers repairing their own tractors. Is there opportunity to pressure for data availability? Some data may be available within these systems, but availability may be subject to change at the whims of the provider, and thus even 3rd party solutions may prove brittle. Further, with the increase in utilisation of network-enabled technologies, there are opportunities for systems to be breached, as has already been exhibited within the agricultural domain(6), so any approach must be applied carefully.

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FUNDING

ACKNOWLEDGEMENTS

NOTES

TO TREAT OR NOT TO TREAT?

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SUMMARY

Probability of cure of a case of clinical mastitis is associated with various cow, pathogen and treatment factors. The aim of this study was to create a model, incorporating only cow characteristics readily available at the time of case detection, for predicting the probability of cure of a case of clinical mastitis during lactation. Using data available from previous research on 52 UK dairy farms, mixed-effects modelling was employed to create a predictive model. Initial validation of this model was then accomplished using cross-validation. Preliminary work suggests the model is highly predictive of cure probability, and has the potential for use in real-time for informing treatment decisions in cases of clinical mastitis.

INTRODUCTION

For economic and welfare reasons, mastitis remains a highly significant disease of dairy cattle [1]. In the UK, the mean incidence of clinical mastitis (CM) has been found to be between 47 and 65 cases/100 cows/year [2]. Whilst prevention of intramammary infection (IMI) is key to reducing the impact of mastitis on dairy units [3], the rate of cure of existing clinical and subclinical infections also plays an important role in control of infection prevalence. Simply put, within-herd prevalence of infection is dependent mainly on the ratio of the rate of new infections to the rate of cures. The potential for IMI to be transferred between cows in a contagious manner further enhances the importance of effective cure; the within-herd cost of CM is heavily determined by rates of transmission and of bacteriological cure [4].

Whether or not an IMI has cured (i.e. the mammary gland has returned to a non-infected state) may be determined with bacteriological examination of pre- and post-treatment quarter milk samples. Such an approach has advantages in that it can confirm that the causal pathogen has been eliminated from a gland, and allows for detection of re-infection, whereby bacteriological cure occurs but the gland is subsequently infected with a different strain or species of pathogen. However, the imperfect sensitivity of bacteriology can also result in a false diagnosis of cure if bacteriology fails to detect a pathogen which remains present in the gland. For practical and financial reasons, such an approach is not commonly used. A more robust method for determining cure is to examine somatic cell counts at milk recordings following a case of CM; cows with persistent low somatic cell

counts, and an absence of subsequent cases of CM, following a case, are said to have cured.

Treatment protocols for CM have been the subject of extensive research. Much recent attention has been paid to the selective treatment of non-severe clinical cases during lactation [5,6], with a particular emphasis on the use of rapid on-farm culture techniques for differentiation of Gram positive and Gram negative infections. If it is expected that antimicrobial therapy will have little impact on the probability of cure of a Gram negative infection, then such therapy can be omitted from a treatment protocol for a Gram negative IMI. Such an approach is not without risks. Whilst infections with certain Gram negative pathogens (notably *Escherichia coli*) have been observed to commonly undergo spontaneous cure in the absence of antimicrobial therapy, persistent infections caused by such organisms are well-recognised. In a UK study, 20% of all clinical cases of *Escherichia coli* mastitis were the result of persistent infections [7]. Spontaneous cure of Gram negative IMI caused by organisms other than *Escherichia coli* is less common [8] and bacteriological cure rates may be reduced in the absence of antimicrobial therapy [8,9]. Furthermore, imperfect diagnostic accuracy of on-farm culture methods can lead to misclassification of pathogens. An alternative framework for determining which cows receive antimicrobial therapy for CM is the concept of "treatment worthiness" of the animal in question. If a cow has a low probability of cure regardless of pathogen or treatment protocol, then antimicrobial therapy may be justifiably withheld under circumstances where reduction of antimicrobial use (AMU) is desirable.

Factors at the cow level associated with probability of cure of IMI include parity, stage of lactation, time of year, previous history of subclinical or clinical mastitis, the number of quarters affected, position of affected quarters (front or back), presence of palpable changes in the affected quarter, teat-end hyperkeratosis and rectal temperature at the time of diagnosis [8,10–18]. It is likely that knowledge of such factors at the time of detection of a case of CM can be used to give an indication of the probability of cure, and thus inform the cost-benefit of treatment (both financial and with regards to increased AMU). Health and productivity records for cows experiencing CM can be used to create statistical models which evaluate the associations of various cow and herd factors with the probability of cure. Given the availability of appropriate information, such models, if well-validated, can be used to predict the probability of cure on new cases of mastitis in a diverse range of cows and farms. The aim of this preliminary study was to create a basic model to predict the probability of cure of cases of CM using data readily available on farm at the time of case detection. Such a model could be used to inform decision making with regards to CM treatment.

MATERIALS & METHODS

Data collation, cleaning and analysis were performed using Access 2019, Excel 2019 (Microsoft Corporation, Redmond, WA, U.S.) and R version 4.1.0

[19]. Data used for training the model were available from previous research in which cases of CM, occurring in 52 UK dairy herds between June 1994 and June 2005, were monitored. For each case, data included characteristics of the cow experiencing CM, including cow identification, herd identification, date of occurrence, number of quarters affected and quarter position (front or back). For a proportion of cases, bacteriological diagnosis was also available. These data were augmented, using commercially available dairy herd recording and analysis software (Total Vet, version 2.7.036, Sum-It Computer Systems Ltd., UK) and historical milk recording data for the cows in the original dataset. For each case of CM, parity, days-in-milk (DIM), milk yield at the latest milk recording, number of previous cases of CM during this lactation and the previous lactation, and past and future somatic cell counts were extracted. In addition, herd-level mastitis parameters at the time of each case were gathered from the software. Cases were eligible for inclusion if they occurred in lactating dairy cows and occurred at least seven days subsequent to a previous case in that cow. A case was defined as having cured if one of the following was true:

1) At each of the three subsequent milk recordings within the same lactation, the composite somatic cell count (SCC) was below 200,000 cells/ml *and* the cow had no subsequent cases of CM during the period up to and including the date of the third subsequent milk recording.

2) At each of the two subsequent milk recordings within the same lactation, the composite SCC was below 100,000 cells/ml *and* the cow had no subsequent cases of CM during the period up to and including the date of the second subsequent milk recording.

Lag periods were applied to subsequent milk recording events and CM events, such that a case of CM within seven days following a previous case was discounted, and such that a SCC above 100,000 or 200,000 cells/ml during the 14 days following the case in question was discounted. Cases with an inadequate number of subsequent milk recordings during the same lactation to determine a successful cure were removed from the data. All remaining cows were classified as failure to cure. Thus a binary dependent variable was defined as cure or failure to cure.

Cow- and herd-level predictor variables were screened using univariable logistic regression. Associations between continuous predictors and the dependent variable were assessed using conditional probability density plots, and continuous predictors were categorised accordingly. Missing values for each predictor were coded as a "Missing" category. Predictor variables associated with the dependent variable with a P-value of less than or equal to 0.2 were carried forward for multivariable analysis. For the multivariable analysis, random-intercept generalised linear mixed models (GLMM) with a logit link were constructed using a forwards then backwards stepwise model selection. The Akaike Information Criterion was used for model selection, yielding a final multivariable model with optimum fit. Cross-validation was used to make predictions using the fixed effects of the selected optimum

GLMM, resulting in predicted probabilities of cure for each case of CM. Predicted probabilities were divided into ten bins of equal intervals of probability, and the ability of the model to accurately predict the probability of cure was assessed by calculating maximum and expected calibration errors (MCE and ECE) as follows,

$$MCE = max_{i=1,...,k}(|o_i - e_i|)$$

$$ECE = \frac{\sum_{i=1}^{k}(|o_i - e_i|)}{k}$$

where *o* and *e* are the observed and predicted proportions of cows that cured in each probability bin, and *k* is the number of probability bins.

RESULTS

Of all the cases of CM in the data, 32.8% of cases cured. Further descriptive statistics are shown in table 1. Independent variables in the final model consisted of features describing lactation stage, parity, previous somatic cell counts during this lactation and the previous lactation, previous history of CM, position and number of affected quarters, season and herd average somatic cell count. The MCE and ECE of the cross-validated predictions of cure probability were -0.12 and -0.02 respectively. In other words, on average across the probability bins, the model predictions are expected to be within 2% of the true value, and within a maximum of 12% of the true value for any given probability bin. Predicted probabilities of the final model are shown in figure 1. Associations between some independent variables and the probability of cure are shown in figure 2, and examples of model predictions on cows with different characteristics are shown in figure 3.

Table 1   Descriptive statistics of selected features of cases of clinical mastitis in the training and testing datasets.

Parameter		Description	
Days-in-milk		**Median**	84
		IQR*	26 - 156
		Min	0
		Max	829
Parity		**Median**	3
		IQR	2 - 5
		Min	1
		Max	14
Season	**Spring**	**%**	26.3
	Summer	**%**	18.8
	Autumn	**%**	24.6
	Winter	**%**	30.3
Number of Quarters Affected	**1**	**%**	90.1
	2	**%**	5.7
	3	**%**	0.8
	4	**%**	3.4
Quarter Position	**Front**	**%**	22.8
	Back	**%**	27.1
	Unknown	**%**	50.1
Case Number (This Lactation)		**Median**	1
		IQR	1 - 2
		Min	1
		Max	13
SCC at latest recording (x 1000 cells/ml)		**Median**	175
		IQR	53 - 687
		Min	0
		Max	9999

* IQR = Interquartile range

Figure 1   Histogram of cross-validated predicted probabilities of cure of clinical mastitis cases using the fixed effects of the final generalised linear mixed model.
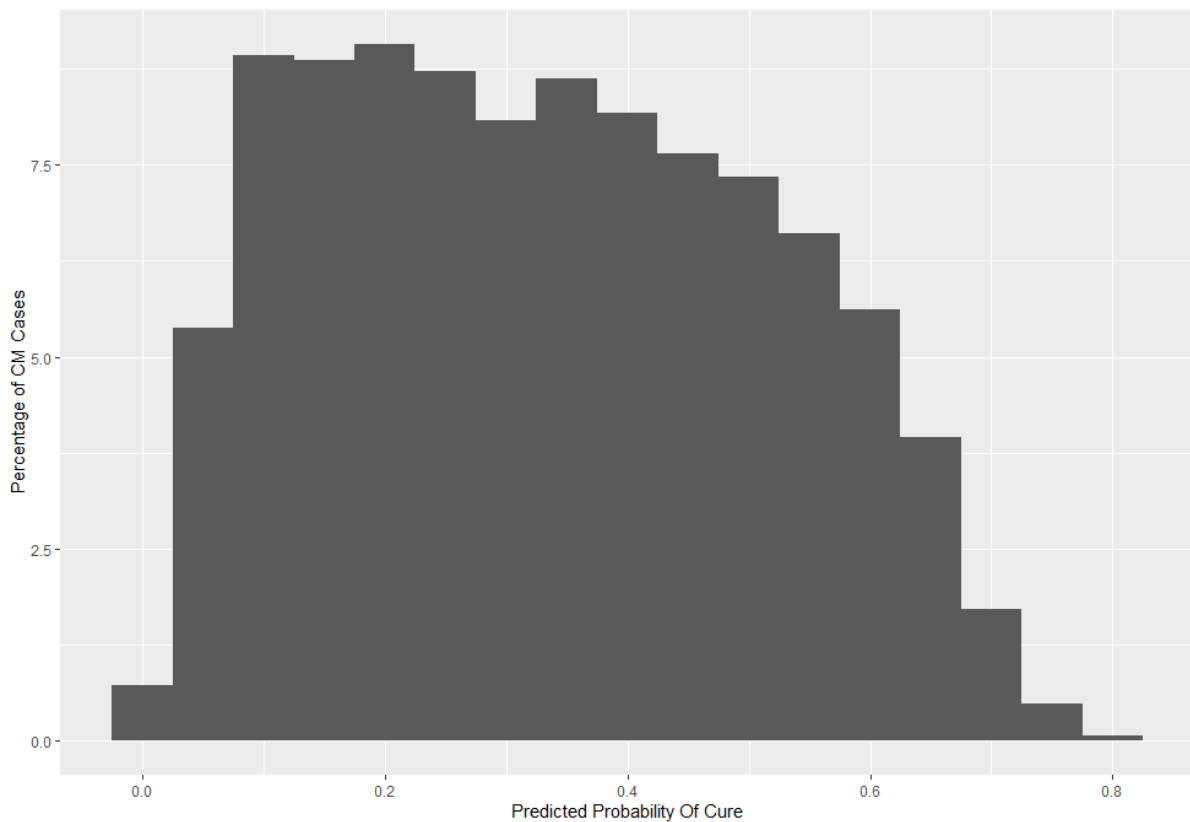
Figure 2   Schematic representation of the associations between some cow characteristics and the probability of cure of a case of clinical mastitis.
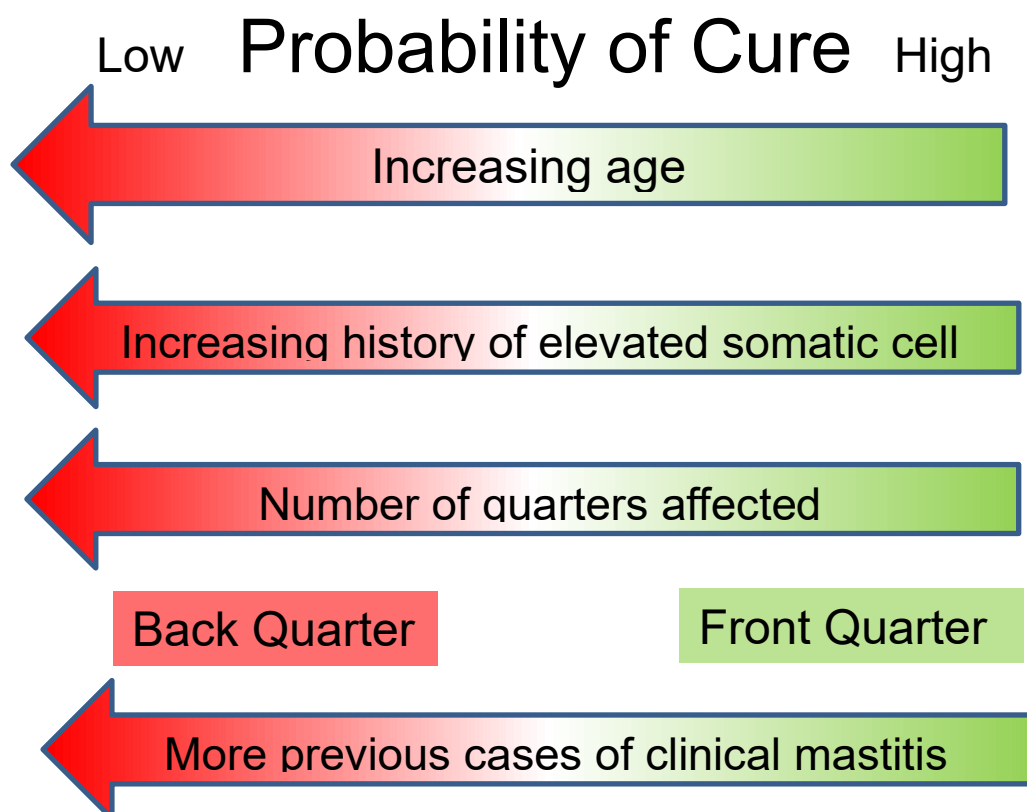
Figure 3   Examples of predictions of cure probability from the model

Lactation 2 Cow 150 DIM* One front quarter affected First case this lactation (Index Case) No cases of CM in previous lactation Latest SCCs: 8 – 28 – 10† **Cure probability 61%**	Lactation 6 Cow 140 DIM Two back quarters affected Second case this lactation Two cases of CM in previous lactation Latest SCCs: 3774 – 2345 – 2410 **Cure probability 2%**

Lactation 6 Cow 140 DIM Two back quarters affected Second case this lactation Two cases of CM in previous lactation Latest SCCs: 3774 – 2345 – 2410 **Cure probability 2%**

*DIM = Days-in-milk
†Somatic cell count at the three most recent milk recordings (x1000 cells/ml)

DISCUSSION

The model presented here is predictive of the probability of cure of a case of CM, and has undergone some initial validation. The model has the potential for use by farmers when making treatment decisions, based on the concept of "treatment worthiness". The results of this preliminary work are in accordance with other research which demonstrates that cow factors are associated with probability of cure of CM. For example, prior somatic cell counts have been associated with the chance of cure [8,14,15]. Age of the cow [8,10–12], lactation stage [12] and time of year [14] have also been found to be associated with probability of bacteriological cure.

Approximately one-third of cases in the data were deemed to have cured according to the current definition. This is consistent with current knowledge regarding the relatively low likelihood of cure during lactation of naturally-occurring IMIs [14,20–23]. Examination of the distribution of cure probability from the model (figure 1) shows that there is a wide variation in cure rates for CM during lactation. Therefore, despite the relatively poor average lactation cure rates in naturally-occurring CM cases, the model presented here is useful for determining which cases have a particularly high or low probability of cure.

The absence from this model of information specifically regarding pathogen is noteworthy, and strongly indicates that decision-making with regards to use of antimicrobials should not be based solely on pathogen identification, or on

Gram status of infecting bacteria, and cow "treatment worthiness" should be considered. Despite being known for some cases, the causal pathogen or pathogen group was not retained in the model. This is surprising as cure rates have been reported to vary with pathogen. Mastitis caused by Gram positive species, for example *Staphylococcus aureus* and *Streptococcus uberis*, has been reported to have a relatively low cure rate [10,12], whereas mastitis caused by *E. coli* has a higher chance of resolution [8]. It is likely that factors retained in the model related to the chronicity of the current infection, and to infection history of the cow, were more important than the specific pathogen diagnosis for the current case. For example, cows with persistent Gram-positive infection are likely to have a history of high somatic cell count.

The results of this preliminary work indicate that probability of cure can be estimated accurately without the need for bacteriological diagnosis. These predictions are useful, especially at the low-end of the range of cure probability. For CM cases with a low probability of cure, the cost-benefit of antimicrobial treatment, or of treatment in general, will be relatively small. For cases predicted to have a high probability of cure, the true cost-benefit of antimicrobial treatment remains unknown due to the absence of information regarding treatment protocol in the data. In other words, the effect of treating or not treating cases with a high cure probability has not been established by this work. However, it could be argued that, given inappropriate treatment, the potential drop in cure rates is relatively greater for cows with a high cure probability.

CONCLUSIONS

The probability of cure of a case of clinical mastitis can be predicted accurately using information available at the time of case detection. Such information includes characteristics of the cow at the time of case detection as well as historical information regarding previous subclinical and clinical mastitis, but excludes identification of the causal pathogen. These predictions could be used in real-time on dairy farms to help inform treatment decisions for individual cows suffering clinical mastitis. Further research to enhance model accuracy should include more extensive validation, and incorporation of treatment records for all cases.

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NOTES

THE IMPACT OF USING TEAT SEAL ONLY AT DRY-OFF ON SCC AND INFECTION LEVELS IN THE FOLLOWING LACTATION ON 5 IRISH COMMERCIAL HERDS

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INTRODUCTION

Blanket antimicrobial dry cow therapy was estimated to be used in nearly 100% of herds in Ireland in 2015 (1). European regulation will come into force in January 2022, restricting the preventative use of antimicrobials in groups of animals (2). An alternative is treating only cows that have or are at high risk of having an infection with antimicrobials, while the remaining cows are treated with an internal teat seal only.

The objective of this study was to assess the impact of using internal teat seal (ITS) alone compared to antibiotic plus ITS (AB+ITS) at dry-off on somatic cell count (SCC) and intramammary infection (IMI) in the following lactation on five commercial Irish dairy herds.

MATERIALS AND METHODS

All herds were spring calving pasture-based systems with herd size ranging from 105 to 250 cows. The study period was from November 2018 (dry-off season) to the end of lactation of 2019. Herds mostly comprised of Holstein-Friesian genetics, however 26%, 33%, and 12% of cows in Herds 1, 2 and 3 comprised of Jersey crossbreds. Cows which had every test day SCC below 200,000 cells/ml were blocked according to lactation, proportion of Holstein-Friesian genetics, average SCC and expected week of calving in the spring 2019. Cows then were sequentially assigned to receive ITS or AB+ITS at dry off. Cows with an SCC record above 200,000 cells/mL were treated with teat seal plus dry cow antibiotic (HiAB+ITS). A total of 842 cows were enrolled for this study.

Herds undertook between 5-8 milk recordings during the 2019 lactation which provided information on cow SCC and lactation milk yield from 2019. We collected quarter milk samples at dry-off, after calving and at mid-lactation for bacteriology and quarter SCC analysis.

Test day SCC was log transformed to log 10 SCC (LogSCC) for analysis. The effect of dry-off group on LogSCC and milk yield was analysed using a mixed model with a cow random effect and fixed effects of parity (2, 3, 4 and 5+), DIM, calving month (February, March, April), herd (1, 2, 3, 4, 5) and

proportion Jersey genetics. The effects of dry-off group on the odds of an IMI in a quarter quarters was quantified a using logistic regression and adjusted for the same fixed effects as the mixed model, and the effect of quarter position.

RESULTS

Overall, the LogSCC of cows in the ITS group were significantly higher than cows in the AB+ITS group and not statistically different to the cows in the HiAB+ITS group. However, the response to treatment differed according to herds; the SCS of the cows in the ITS group in Herd 3, 4 and 5 were not statistically different to the cows in AB+ITS group whereas in the other two herds the SCS was significantly higher in the ITS when compared to the AB+ITS group. When cows with a bacteria detected at dry-off were removed from the analysis the overall effect across the 5 herds was similar to that of the full data set. The odds of a quarter with an IMI at calving was 7.0 (CI: 3.6-13.4) and 5.3 (CI: 2.7-10.3) higher for cows in the ITS group compared to the AB+ITS and HiAB+ITS groups respectively. In mid lactation, the odds of a quarter with an IMI in the ITS cows were 6.6 (CI: 3.5-12.4) times higher than the AB+ITS group, but not statistically different between the ITS and HiAB+ITS groups. The odds of a new IMI after calving (not infected at dry-off but infected at calving) in ITS cows were 6.3 (CI: 3.0-13.3) and 7.9 (CI: 3.1-20.6) times higher than AB+ITS and HiAB+ITS cows, respectively. The odds of a cured IMI (infected at dry-off and not infected at calving) was 11.4 (CI: 3.6-36.0) and 11.8 (CI: 2.4-36.5) times higher in the HiAB+ITS and AB+ITS groups, respectively, compared to the ITS group. *Staphylococcus aureus* was the predominant pathogen on all five herds.

CONCLUSION

There was evidence that using ITS alone resulted in higher SCC and increased risk of IMI in the following lactation compared to intramammary antimicrobials plus ITS at dry-off for these 5 commercial herds.

ACKNOWLEDGEMENTS

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NOTES

ONLINE TRAINING FOR ADVISERS TO SUPPORT UDDER HEALTH IMPROVEMENT THROUGH THE QUARTERPRO INITIATIVE.

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The QuarterPRO Udder Health Initiative is an accessible approach to monitoring, understanding and improving udder health, with the aim of helping dairy farmers achieve continuous improvement in mastitis control and udder health (see https://ahdb.org.uk/quarterpro).

The scheme is based on research carried out by the University of Nottingham and QMMS Ltd, and was launched by AHDB in Spring 2020. The approach begins with analysis of a milk recording (cdl) file including clinical mastitis records.

Farmers are encouraged to work with their veterinary and agricultural advisers, every quarter, to analyse mastitis records and:

Predict patterns of infection;

React using pattern-specific resources available from:
https://ahdb.org.uk/quarterpro;

Optimise ongoing mastitis control through quarterly review

Although progressive farmers may be able to work through this approach themselves, much benefit will be gained from the farmer and their vet/adviser working together. Within the framework of QuarterPRO, advisors may wish to direct farmers to the detailed Mastitis Control Plan, found at https://www.mastitiscontrolplan.co.uk/, for a more detailed and structured approach to the development of farm-specific recommendations. This would be carried out by a trained Plan Deliverer.

An online training course, hosted by the British Cattle Veterinary Association (BCVA), has been set up for vets and advisers who wish to become registered as accredited QuarterPRO advisers. This is available at:
https://www.bcva.org.uk/content/quarterpro-adviser-training and takes roughly four hours to complete.

The course consists of four modules which are made available as recorded presentations, each with a related set of multiple choice questions, plus a final

session which involves working on some provided datasets, and questions relating to these. Successful completion of all the questions will trigger registration with BCVA as an accredited QuarterPRO adviser. An interactive map of BCVA Accredited QuarterPRO Advisors (BAQAs) can be found on the BCVA website. Furthermore the BAQA logo can be added to email signatures to demonstrate accreditation if wished.

Registration for the course costs £10 for BCVA members and £55 for non-members.

QuarterPRO is designed as an "entry level" approach to mastitis control, for frequent use. For more detailed investigations the Mastitis Control Plan https://www.mastitiscontrolplan.co.uk/ is recommended.

ACKNOWLEDGEMENTS

NOTES

SURVIVAL OF STREPTOCOCCUS UBERIS ON BEDDING SUBSTRATES

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Streptococcus uberis (S. uberis) has been reported to be the most prevalent mastitis pathogen in the United Kingdom[1]. Infection with this pathogen arises predominantly from the environment and it has been isolated from different niches within the environment [2,3], including different bedding materials[4]. Previous research has shown that the ability of different *S. uberis* strains to survive on different materials varies between strains of the bacterium and between bedding types[5]. This suggests that there are specific genes which may be beneficial for survival in certain environments.

To investigate this four mutant strains of *S. uberis*, each with a known single genetic lesion were used (Table 1). Clean bedding substrates (sand, pine sawdust, wheat straw) were collected from two commercial dairy farms and sterilized ($121^{o}C$ 15 min). Each bedding substrate was inoculated with the genetically intact parent strain (0140J) or one of the four mutants (lacking: srtA - responsible for anchoring a subset of proteins at the bacterial cell wall, mtuA - responsible for the high affinity acquisition of Mn^{2+}, vru - a transcriptional regulator known to control virulence, *has*A - responsible for hyaluronic acid capsule production).

Bedding materials were sampled for *S. uberis* at 0, 24 hours and 7, 14, 21 and 28 days post inoculation, as previously been described[5]. If no bacteria were detected (detection limit 100cfu), then enrichment was performed by addition of 5ml Brain Heart Infusion broth (Oxoid) and overnight incubation at 37°C.

None of the isogenic mutants were recovered on any of the bedding substrates over the 28 day sampling period (Table 1). None of the isogenic mutants survived past the initial sampling time point of 0 hours, whilst strain 0140J was only recovered up to 24 hours. The mutants had the same survival time on the clean sawdust as the wildtype 0140J, however there was a decreased survival time of the isogenic mutants in comparison to 0140J on clean sand bedding, except for mtuA. On clean straw bedding, there was an increased survival time of isogenic mutants compared to the wildtype strain 0140J.

Table 1 Survival of *Streptococcus uberis* (strain 0140J) and four mutants derived therefrom on three bedding substrates and in saline (None), over a period of 28 days. Samples were taken at 0, 24 hours, 7, 14, 21 and 28 days. Enrichment was used if *S. uberis* was not detected using the standard recovery protocol. Enrichment involved the addition of 5ml of BHI for an overnight culture at 37°C.

Bacterial strain	Survival in Bedding material (days)							
	Straw		Sand		Sawdust		None	
	Enrichment		Enrichment		Enrichment		Enrichment	
	No	Yes	No	Yes	No	Yes	No	Yes
0140J	7	28	28	-	1	NT	1	NT
srtA	14	28	14	28	0	NT	0	NT
mtuA	28	-	28	-	0	NT	1	NT
vru	14	21	14	28	0	NT	0	NT
hasA	7	28	14	28	0	NT	0	NT

NT: not tested

Like the wild type none of the mutants survived beyond 1 day in the absence of bedding materials or when incubated on sawdust. There was some variation in the survival of mutant strains on straw and sand.

The strain with a mutation in *mtuA* lacks the ability to actively uptake manganese and is unable to infect the lactating[6]; however its survival on straw and sand was not impaired.

The *hasA* mutant lacks the ability of produce the hyaluronic acid capsule, which has been hypothesised to play a role in preventing desiccation in the environment[7]. The mutant showed a slightly decreased ability to survive on sand but it's survival on straw, compared to 0140J. These data are similar to those reported for the non-capsulated strain, EF20[5] and suggest that capsule does not influence bacterial survival.

The vru mutant has an insertional mutation within a transcriptional regulator (promoter). This mutation has been shown previously to result in down regulation of a number of genes within *S. uberis* and result in impaired colonisation of the lactating bovine mammary gland. This altered gene expression did not appear to markedly impact the survival of the *S. uberis* on bedding substrates, although some variation compared the wild type was detected.

The srtA mutant has an insertional mutation which disrupts anchoring of surface proteins on the cell wall. This strain has previously been shown to be less able to persist at high bacterial numbers in the lactating bovine mammary gland compared to the wild type (parental) strain. The srtA mutant did not survive in as well as 0140J on sand; however it was still present at Day 28 after enrichment, suggesting that whilst these surface proteins have been shown to be essential for causing mastitis[8,9], the *srtA* gene product is

not essential for environmental survival (and thus by inference neither is correct anchoring of SrtA's substrate proteins).

S. uberis is a nutritionally fastidious organism that has evolved to survive in a variety of nutritionally challenging environments. The data outlined here supports a previous finding that *S. uberis* does not survive well in the absence of bedding material or on sawdust bedding and that the organism may persist for 28 days on sand and straw bedding. However, this environmental survival does not appear to rely on the presence of a hyaluronic acid capsule, the ability to actively acquire manganese or the presence of other known virulence factors. The conclusion is that distinct sub-sets of genes are required for virulence and environmental survival.

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NOTES

DESCRIPTIVE STUDY OF BACTOSCAN FAILURES ON UK DAIRY FARMS (2010-2020)

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Bulk milk bacterial count is a key indicator of milk quality. In practice, bactoscan testing offers a quicker approximation of Total Bacterial Count (TBC): a bactoscan value of ≥30,000 impulses/ml is roughly correlated with a Total Bacterial Count of ≥5,000 cfu/ml. In the past 10 years, average bactoscan of UK milk has reduced from 31 to 27,000 impulses/ml, this is likely driven by improved hygiene across the milk harvesting process.

The aims of this study were to describe common causes of high bulk milk bacterial counts (TBC ≥5,000 cfu/ml), using results from bulk tank investigations compiled by QMMS between 2010 and 2020. Samples were analysed for Total Bacterial Count, Thermoduric Count, Coliform Count, Psychrotrophic Count and by direct plating to identify which species were present. Samples with a TBC <5,000 were excluded, based on the combination of results, the remaining samples were classified as:
1. E - Environmental contamination caused by suboptimal teat cleanliness, preparation or milking hygiene
2. M - Mastitis associated with *Streptococcus* species
3. P - Suboptimal plant cleaning
4. C - Problems with milk cooling and storage
5. W - Environmental contamination from water-borne bacteria

Table 1 Number and proportion of samples with a single or mixed diagnosis

	N	%
Unknown	3	0.4
1 problem	485	71.9
Mixed 2 problems	174	25.7
Mixed 3 problems	13	1.9
Total	675	100

A single diagnosis was reached in the majority of cases (Table 1). Table 2 shows the number and proportion of high TVCs by each diagnosis. The most commonly identified problem was mastitis pathogens causing a high TVC. *Streptococcus* spp. (particularly *S. uberis*) can be shed intermittently but sometimes in very high numbers from cases of subclinical and clinical mastitis. In an average size herd (100-200 cows) it is possible for a single infected cow to cause spikes in bulk tank bacterial count. Effective mastitis detection should play an important role in maintaining milk quality: this

includes foremilking of every cow at each milking, and regular surveillance of subclinical infection through milk recording.

Table 2 Number and proportion of samples by diagnosis
*Note that percentages don't add up to 100% due to multiple diagnoses in some samples

	N	%
M - Mastitis (*Streptococcus* spp.)	236	34.9
W - Water quality issues	187	27.7
C - Milk cooling and storage	181	26.8
P - Plant cleaning	147	21.7
E - Teat preparation and milking hygiene	121	17.9

As far as the authors are aware, this is the first study to highlight the importance of water quality in bulk tank failures. More than a quarter of bulk tanks had evidence of water-borne bacteria, the most common of which was *Pseudomonas fluorescens*. The most likely source of these bacteria is water from hoses used for washing clusters or cows in the parlour. *Pseudomonas fluorescens* also has the potential to cause chronic mastitis and tends to be resistant to many 1st line antibiotics. It is therefore important that farms are testing the 'potable' water used in the parlour, particularly if sourced from a borehole, or recycled from the plate cooler.

Between 2003 and 2020, AHDB Dairy have published figures showing a drop in average bactoscan value from 32,000 to 27,000 impulses/ml. This is likely driven by more hygienic practice and more awareness of milk quality. Historically, many bactoscan problems were put down to suboptimal teat cleanliness and/or preparation, however this diagnosis was made in very few cases. This finding could reflect improved cow cleanliness and more consistent use of pre-milking teat disinfection over the past 20 years.

In summary, these results demonstrate that bactoscan failures can be caused by problems in several different areas of the milk harvesting process. In this study, nearly a third of bulk tank failures were caused by more than one problem. Thorough work-up of bulk tank bacteriology is therefore essential in reaching an accurate and meaningful diagnosis, and for follow-up monitoring.

NOTES

THE CHALLENGES OF SETTING UP A SMALL-SCALE DIRECT SUPPLY BUSINESS

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SUMMARY

We farm close to a city so wanted to make the most our location and direct sell to the public. Our Arla contract has limited our initial ambitions to two vending machines. Post-pasteurisation contamination has been the biggest ongoing challenge as the relatively small volumes allow very little room for error. However direct positive feedback from customers gives us all a real boost.

1. BACTERIOLOGY

We sell batch (low-temperature-long-time) pasteurised milk. Monitoring the temperature & time has resulted in consistently effective pasteurisation, however we have had issues with *Enterobacteriacae* contamination which have been difficult to solve at times.

We shelf-life tested before we began selling our milk with good results. A routine sampling after a month gave a 0 coliform count, however the next routine sample 3weeks' later had a coliform count of 11. All joints and fittings were dismantled & cleaned, the cleaning schedule was reviewed. We repeated the sample 7 days later & results were worse. (It takes 5 days to get the result from day of sampling). We panicked & rang Andrew Bradley of Quality Milk Management Services, QMMS, who advised to investigate especially for rust, outside of bungs & to leave cleaning chemicals insitu until a final rinse just prior to use. Eventually a stainless steel U-bend that had been made up by the dairy company who fitted the pasteuriser was found to have rusty internal welds. We stopped using this, added a peracetic final rinse and then took samples from the pasteuriser directly, through the milk pump & out of the churn and sent the 3 samples for pasteurised milk screening & direct plating. All coliform counts were 0.

2. LOCATION OF VENDING MACHINE

Needs to be handy for people buying milk, a mile long lane with potholes, won't encourage sales. However, once milk is sold off-site, increased standards are required by Environmental Health. This also takes much more time and people don't always understand your relationship with the farm shop or other location.

3. TYPE OF PASTEURISER

- ➢ LTLT = low temperature, long time = 63°C, 30 minutes
  Also known as batch pasteurizing; considered more "gentle".
- ➢ HTST = high temperature, short time = 72 °C, 16 seconds
  Also known as continuous flow pasteurizing; easier for bottling, used larger scale.

Possibly affects taste? Electric supply can limit size and scale of either option. We didn't consider selling raw milk as the reasonable chance of getting tuberculosis in the herd is too high risk in mid-Devon.

4. TYPE OF VENDING MACHINE

We barely considered bottling & selling as this probably requires real scale to be economic, certainly takes a lot more time to deliver, bottle washing & much promotion
Our biggest considerations in vending machine type were cleaning in place (CIP) versus off-site (ie back to the farm), churn size +/- wheels, messaging/alarming abilities of the machine (including compliance for monitoring), payment mechanisms.

We added selling flavoured milk later on as dispensing machines weren't available at the time. We do sell clean new bottles but no other extras (such as eggs, cheese, butter)

5. ENVIRONMENTAL HEALTH

The rules and regulations for selling pasteurised milk direct to the public, unbottled are not clear cut as this is quite a new option. What regulations you have to adhere to is therefore very much determined by the Environmental Health Officer (EHO) that you are allocated. We felt that the resin floor with wall-to-floor junction curved & step over barriers in our pasteurising room seemed excessive compared to other people's requirements initially. Our EHO was also initially adamant that we needed an EU oval on our bottle labels, which held bottle printing up for several weeks. He then realised that it was not needed because we are selling empty bottles, not bottled milk.
However, our EHO accepted the sampling requirements that we proposed in our HACCP (Hazard Analysis Critical Control Plan) which were suggested to us by Andrew Bradley, QMMS, whereas other local direct milk sellers were having to send in 5 samples each time on a weekly basis for the first 2 months. We test monthly:

- ➢ ALP: residual alkaline phosphase which is an indicator of adequate pasteurisation & is done by Fluorophos method, the lower the result the better and should be <100mU/litre.

> ➢ Total viable count – which typically is around 200-300 even after effective pasteurisation
> ➢ *Enterobacteriaceae* count: allowable limit is 1 in 5 samples allowed to be up to count of 5, rest have to be 0, however limit set in EC 2073-2005 = 10cfu/ml

Milk also has to be tested for somatic cell count, bactoscan of raw milk and antibiotics - but if selling milk to a processor this is covered by their testing. As we usually don't milk over the winter, we sample weekly for these during this time. We also keep reference samples of each day's milk for 7 days.

Our EHO was happy with our sealed churns to transport milk, other farmers have had issues with EHOs concerned about the wheels picking up contamination.

Writing a HACCP can be a challenge, various templates for similar processes can be found and many tedious hours of lectures at vet school must have slightly sunk in.

EHOs are able to sample milk on an unannounced basis, not always letting you know the results unless they are not fully satisfactory.

A Southwest working group of EHOs is apparently being set up to formulate a consistent approach to direct milk selling.

Other milk venders have had issues with other contamination, such as *Cryptosporidium parvum.* One case was related to a shortage of bottles: a farm worker was approached by members of the public and went to fetch a few bottles without having washed and had just fed sick calves. A second incident was related to someone not washing properly and contaminating a whole batch of milk post-pasteurisation causing a bigger outbreak.

6. TIME

This is another daily commitment. Heating up, batch pasteurising and cooling the milk takes around 3 hours. We then have to deliver it, surface clean the machines & clean the pasteuriser and churns daily.
The set-up is a new bit of kit to be on-call to – generally very reliable but failures never happen at convenient moments!

7. CLEANING

Chemicals and processes are similar to general dairy cleaning but the pasteuriser requires physically cleaning so we use different chemicals. Each churn gets acid washed weekly. We peracetic rinse through.
Surface cleaning products can be awkward as most that are compliant to BSEN1276 and BSEN13697 are quaternary ammonium compounds (QACs) and are not allowable on dairy farms.

8. SOCIAL MEDIA & ADVERTISING

This has to be done, doesn't come naturally to me so have got staff involved. We have held Open Farm Sunday farm walks for 5 years so bravely enlarged it this year.

9. MILK QUALITY

Dispensing flow meters do not cope well with higher fat milk and tend to overfill bottles causing annoyance to customers, mess and waste, plus call outs.

10. MILKING COWS IN THE WINTER

We are spring block calving and usually dry off the whole herd before Christmas, not planning to start the machine up again until February. So, we milked through some late April cows & a few empties but have to milk more than we think we need as we can't turn dried-off cows back on again if we get short of milk.

11. GOOD COW FERTILITY

Our last major problem is tightening our calving pattern to a 6-week block for 2022 = no later cows to milk through!

ACKNOWLEDGEMENTS

NOTES

MANAGING OUTCOMES: WHAT DOES THE DATA SHOW?

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SUMMARY

The big data revolution has pervaded all areas of society over the past decade, and udder health management has seen a revolution in the way that data is used to support decision making. This has mostly been focused on herd-level decisions. This article discusses some potential areas of future development in the role of data to measure and predict outcomes in udder health, both at herd level and at individual cow level.

INTRODUCTION

The role of data in monitoring dairy herd health has become ever more important over the past decade. This has been facilitated by a number of factors, including better data recording (itself enabled by wider uptake of computer-based recording systems) and an increased awareness of the benefits of using data effectively, both amongst producers and from other supply chain stakeholders. Increased herd sizes have also contributed to the trend, as larger herds tend to have better data, and require less time to collect a sufficient "sample size" for monitoring, meaning that a cycle of measurement, intervention and review has a shorter timescale.

USING DATA TO MEASURE UDDER HEALTH OUTCOMES

Udder health could make a reasonable claim to be the aspect of herd health which has shown the biggest progress in how data is used over recent years. It is now widely accepted that analysis of data is a vital first step in addressing mastitis control, whether in the context of routine monitoring or investigating a problem. The AHDB Dairy Mastitis Control Plan and recent QuarterPRO initiative exemplify this concept, and have seen widespread adoption and huge reach within the UK industry since the original launch of the plan in 2009 [1].

Mastitis control also provides a good example of the concept of a "hierarchical" approach to data analysis – in most contexts, the main herd outcome measures of interest are the incidence rate of clinical mastitis and the bulk milk somatic cell count (SCC). However, these two figures give little insight into the epidemiology of udder health on a particular unit, and alone are usually a poor foundation for decision making around interventions to improve performance.

Where these headline outcomes are failing to reach targets, more detailed data analysis is justified. Very briefly, this further evaluation generally focuses on two key aspects: the predominant mode of transmission of mastitis (environmental or contagious) and, where transmission is mostly environmental, also on the risk period for infection (dry period versus lactation). Although these are conceptually quite simple, assignment of a predominant "herd pattern" requires in-depth analysis of herd data, as well as substantial element of skill on the part of the individual undertaking the assessment. Performing this analysis effectively involves assessment of a number of different measures of performance (e.g. rate of clinical mastitis in the first 30 days in milk, rate of dry period and lactation new infection as measured by SCC etc), and evaluating trends over time, seasonality and the impact of subsets of cows within the herd (e.g. first lactation heifers). Development of software tools to make this consistent and accessible has been fundamental to the widespread adoption of this approach to mastitis control.

WHAT DOES THE FUTURE LOOK LIKE?

Increased availability and adoption of decision support tools in dairy herd health is likely to be a key future development. Lack of access to the expertise and software tools required to make a herd pattern diagnosis was identified as a limiting factor in the reach of the AHDB Dairy Mastitis Control Plan, and in part led to the QuarterPRO initiative, which provides an automated tool to assist in classifying herd pattern. This was developed by the originators of the control plan, and is effectively an attempt to formalise the way subject specialists would approach the problem using a weighted scoring system.

Machine learning methods are a common approach to automate this process further, and there are a number of widely cited examples of the application of this approach to individual diagnosis in human medicine. A recent study [2] evaluated the accuracy of machine learning to classify herd mastitis pattern, with machine learning algorithms trained on and compared to an expert diagnosis. Performance on classifying contagious versus environmental patterns was good, and although accuracy was lower for the (generally more challenging) classification of lactation versus dry period origin this model still showed substantial promise. This provides a further route to make effective mastitis control based on data driven decisions even more accessible, and it is likely that more herd-level decision support tools based on machine learning and other predictive analytics techniques will become available in future.

These approaches are also valuable at individual animal level, with potential to predict outcomes in a way that can influence the management of individual cows. Examples of the use of machine learning to predict outcomes in this field include insemination outcome [3], timing of calving [4] and occurrence of clinical mastitis [5].

Prediction performance of these models is quite variable across the different outcomes, and a particular issue in this area is that there are several commonly used metrics used to measure this. Accuracy (the proportion of predictions made which are correct compared to a gold standard measurement) is perhaps the most commonly reported and the simplest to understand. However, this measure can be quite misleading where the outcome is very "unbalanced" (e.g. where the objective is to predict occurrence of a relatively rare event). In this instance, an algorithm which predicts the more common outcome in almost all cases will have an impressive-sounding accuracy. As a minimum, it is useful also to evaluate the sensitivity (proportion of observed events which were predicted by the model) and positive predictive value (proportion of positive predictions which are associated with a true observed event).

Machine learning algorithms are also used in most commercially available sensor technology systems in dairy cattle. In the field of udder health, automated mastitis detection (generally within automatic milking systems) is perhaps the most common example. Generally such systems use multiple different data "inputs" which are evaluated together to generate predictions. A major challenge in this area is the lack of a good evidence base on which to evaluate or compare such systems. In some respects, this is an inherent problem – the model used to combine data sources and make predictions is likely to have as large a role to play as the sensors themselves in determining effectiveness of the system, and algorithms are continuously being developed, refined and updated. Therefore, studies assessing performance of these systems can quickly become outdated. Some of these challenges are reviewed by van der Voort et al. [6].

Another emerging method to support decision making is the use of simulation. This can be highly useful in evaluating the likely outcomes of potential herd level interventions, especially where research directly comparing the alternatives under consideration does not exist or is not possible (for example, if the proposed interventions affect different aspects of the system). This approach can also incorporate uncertainty in study results, potentially giving decision makers a clearer idea of the likelihood of different outcomes.

This method has been used to some extent as a research tool, especially to assess the impacts of dairy cow health issues such as ketosis [7], clinical mastitis [8] and reproduction [9]. However, such models are also highly applicable to supporting decision making, and there have been some examples of this; for example in evaluating likely economic outcomes of changes in reproductive performance [10].

Another area where development is likely is in systems that support use of data by aggregating data from different sources, and either providing analytics as part of a service, or making the data more accessible for users. There are already examples of this in agriculture (especially in the arable sector), but it is likely that the next few years will see more activity in this area.

CONCLUSIONS

Udder health has seen a massive improvement in the extent to which data is used to support decision making over the past decade, especially in terms of herd level control. This trend is likely to continue, as tools to support this process become more sophisticated and more accessible; there is also substantial scope to use data more effectively to support decisions at the individual cow level.

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NOTES

AHDB MASTITIS CONTROL PLAN CASE STUDY: ENVIRONMENTAL LACTATION PATTERN IN A ROBOTIC MILKING HERD

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SUMMARY

An AHDB Mastitis Control Plan on a 110 cow AMS milked Arla 360 dairy herd began in October 2020 at the request of the client, due to penalties resulting from high bulk milk somatic cell count (BMSCC), which at that time had a twelve month average of 271,000 cells/ml. Analysis of the data using the Mastitis Pattern Analysis Tool indicated the predominant pattern was that of new infections arising during lactation. The farm management plan agreed with the client focussed on improvements to the lactating cow environment, especially frequency of bedding application and a high standard of slurry scraping; and also highlighted issues associated with mastitis identification and treatment.

Lactational udder health parameters improved dramatically over the next four months, at which point concentration was required on the dry period environment. Agreed goals included managing the dry period environment to the same standard, especially bedding and slurry procedures. At the second review, dry period new infections were much improved but lactation new infections were starting to deteriorate.

At the final twelve month review, lactational and dry udder health had significantly deteriorated over the summer due to two important factors: increased numbers of cows calving in July and August; and an interruption in the supply of bedding material. The figures were still better than those of October 2020, however the client was well aware they had lost a lot of ground. The conclusion was that this confirmed the original farm management plan had been a success, not just a coincidence, and it motivated the staff to return to the previous improved standards of environmental hygiene management.

INTRODUCTION

The AHDB Mastitis Control Plan (MCP) was launched in 2008 after a randomised controlled trial demonstrating the many benefits of a systematic and holistic approach to udder health in dairy farms[1]. The first three years involved training of Plan Deliverers throughout the UK and using their experiences and data to model future use and development of the MCP[2,3].

In 2020, a simplified and shorter version of the MCP, QuarterPRO, was made available[4], with the recognition that many farms may prefer a lighter touch

surveillance-style program where there is no sudden or severe breakdown in udder health. The process adheres to the same principles of data analysis and working with clients to create an agreed farm management plan.

This case report describes an AHDB MCP carried out for a small Arla 360 dairy farm, and the twelve month follow up to the plan.

Assistance was sought for a family run dairy herd milking 90 cows by AMS (2 Automatic Milking Systems), after a steady increase in bulk milk somatic cell count (BMSCC) resulted in suspension from their Arla 360 milk contract. At presentation in October 2020, the BMSCC was 265,000 cells/ml, with a three month average of 231,000 cells/ml and a twelve month average of 271,000 cells/ml. To achieve compliance with Arla 360 targets, twelve month rolling average was required to be below 200,000 cells/ml, together with avoiding three consecutive readings above 200,000 cells/ml.

A farm summary is presented in Table 1.

Table 1: Farm Management Summary

Parameter	
Herd Size	110 cow herd, 90 cows in milk.
Calving Pattern	All year round
Replacements	Homebred only
Milk Production	9,405 litres 305 day production (cow)
Milking System	AMS; two robots
Housing	Housed continually in cubicles (lactating and dry); straw yard for calving
Milk Recording	NMR
Clinical Mastitis Recording	Recorded on farm database and supplied to NMR

IMPLEMENTATION OF THE PLAN: DATA ANALYSIS

Prior to the first visit, farm data was obtained from NMR and analysed using TotalVet. This was the first time that sufficient quality data was available for analysis since the farm had only been milk recording for 12 months. Table 2 shows initial key performance indicators (KPIs) for udder health. All parameters were significantly higher than target, except dry period cure rate, with resulting estimated financial losses of £364.60 due to cell count and £4180 for all mastitis losses.

Table 2: Udder Health KPIs at October 2020

	Oct 2020	3 month rolling average	12 month rolling average	Target
BMSCC	265	231	271	<200
Lactation New Infection Rate	15.5	14.6	14.5	<5
Dry Period New Infection Rate	25.0	25.0	21.3	<10
Dry Period Cure Rate	100	84.6	61.5	>85
% herd chronically infected	22.7	18.2	14.7	<5
% herd >200,000 cells/ml	35.2	30.0	27.3	<20
Clinical Mastitis cases/100 cows/year	49	60	36	<25

Mastitis Pattern Analysis indicated that the current predominant issue was Environmental Lactation (EL), with both EL and Environmental Dry Period (EDP) as significant recent issues, as illustrated in Figure 1.

Figure 1: Mastitis Pattern Analysis, October 2020
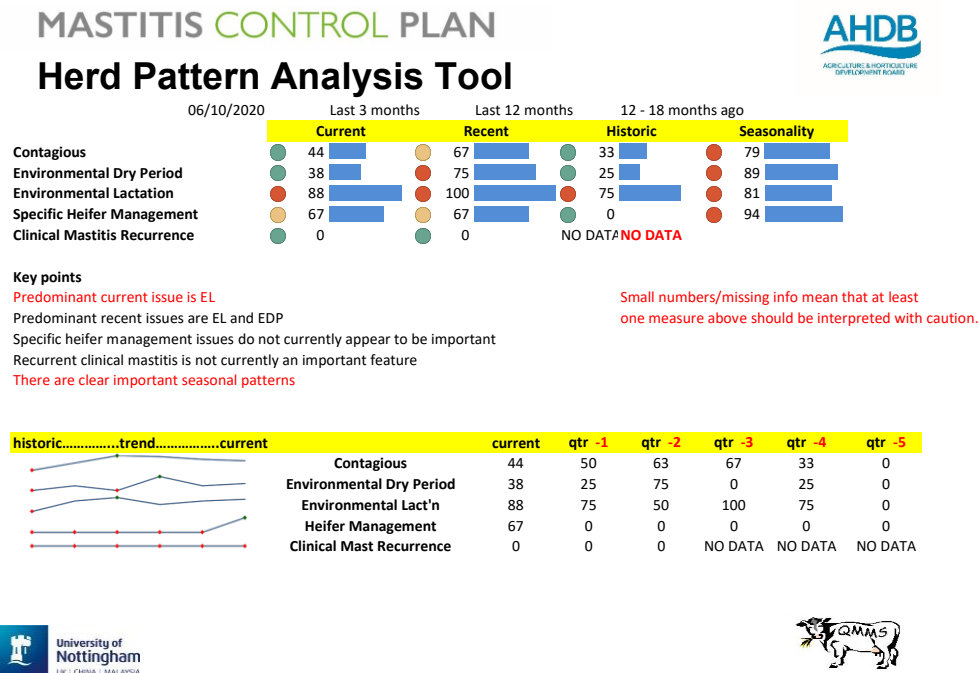
Cell Count Performance

Cell count performance data for the last twelve months is presented in Figures 2 (Lactation New Infections) and 3 (Dry Period New Infections).

Figure 2: Lactation New Infections to October 2020
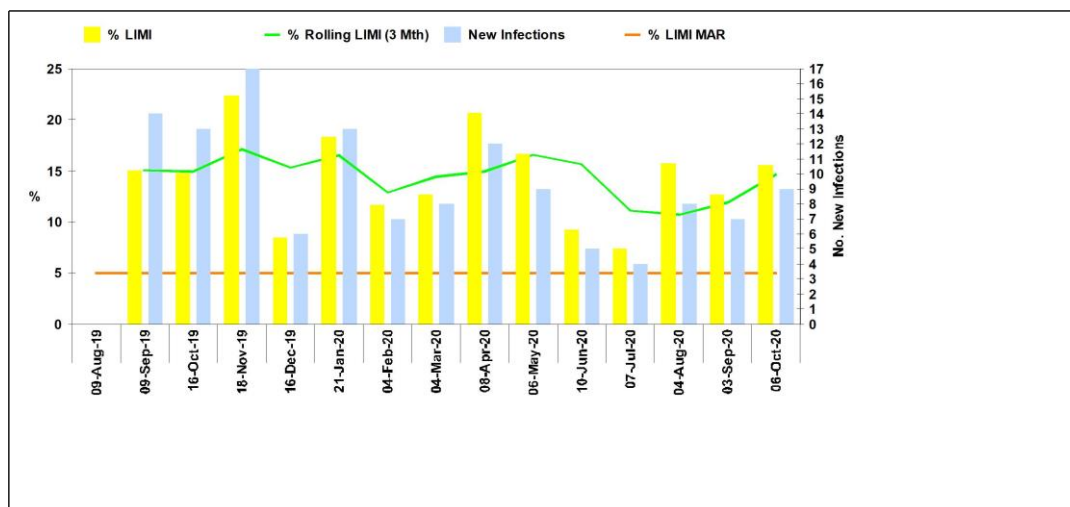
Lactation new infections were significantly above target levels, with a third of the cows contributing to the bulk tank having a somatic cell count (SCC) of greater than 200,000 cells/ml. Approximately half of the infections resulted

in chronic infections. When stale cows of greater than 200 days in milk were removed, the lactation new infection rate was still twice the target (10%).

Figure 3: Dry Period New Infections to October 2020
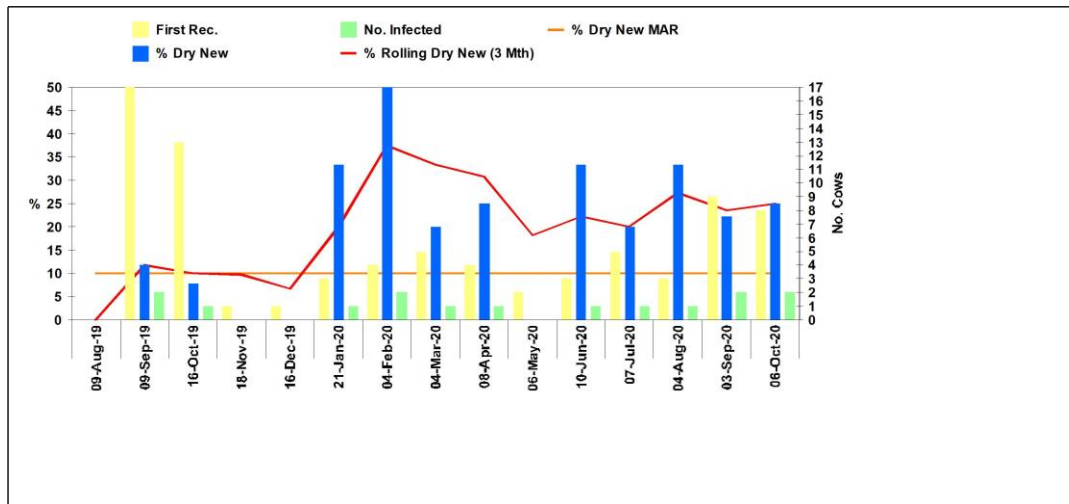
Dry period new infections were also above target, with 35% of cows with a high cell count at their first recording. Heifers did not show an increased rate of first recording high cell count, but the numbers were small. Dry period cure rate tended to be below target, but this likely reflected reinfection rather than failure to cure.

Clinical Mastitis Performance

Clinical mastitis data for the last twelve months is presented in Figure 4 and indicates that lactational infections had been predominant since June. Clinical mastitis recording began in January 2020 and so data prior to this is unavailable.

Figure 4: Clinical Mastitis to October 2020
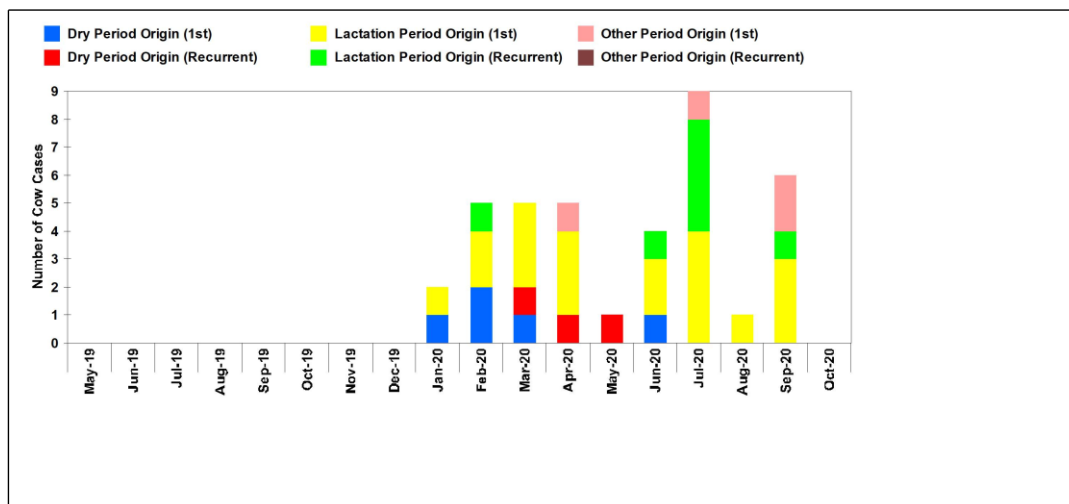
Bacteriology

Aseptically collected milk samples from four acute clinical mastitis cases were submitted for bacteriology. Three produced a pure heavy growth of *Escherichia coli* and one a mixed heavy growth of *E. coli* and *Proteus mirabilis*.

IMPLEMENTATION OF THE PLAN: OBSERVATIONS AND QUESTIONS

A farm visit was conducted for the AHDB MCP Questionnaire to be answered, focusing on the environment of the lactating cows. Herd management and husbandry were thoroughly discussed, and appropriate housing measurements taken. The function of the robots, udder health recording and the approach to clinical mastitis cases and high cell count individuals were reviewed.

IMPLEMENTATION OF THE PLAN: SELECTION OF CONTROL PRIORITIES

Key areas highlighted during the first farm visit were: frequency of fresh bedding application for lactating cows; slurry management; incorrectly recording high conductivity as clinical mastitis; incorrect treatment of clinical mastitis; use of the calving yard as a 'sick pen'; and cows running milk in the cubicles.

An automatically generated list from the ePlan software was refined to a list of eleven key changes to be presented to the farm management for consideration and prioritisation. These were:

Hygiene:
➢ Apply fresh sawdust to the cubicles daily
➢ Clip tails and flame udders every 2 months
➢ To reduce the number of cows running milk, ensure that food is pushed up five times daily to prevent busy times at the robots, and encourage other activities at the other end of the yard, for example with brushes and loafing space.
➢ Do not put sick cows in the straw yard with fresh cows.
➢ Increase contact time with pre-milking teat disinfectant in robot
➢ Manual scrape of passageways to 'mop up' what auto scraper leaves behind
➢ Do not house sick cows in the calving yard

Mastitis Protocols:
➢ Distinguish between cows with high cell count and cows with mastitis and follow the treatment protocol for each one.
➢ Do not use injectable antibiotics as well as intramammary antibiotics to treat mastitis.
➢ Use an anti-inflammatory when treating cows with mastitis.

Monitoring and recording:
- Cows with high conductivity should not be recorded as clinical mastitis cases
- Monitor mastitis and cell count records every three months

Other:
- To dry off cows giving more than 15 litres, reduce feed in the robot and reduce visits to the robots in the period leading up to drying off
- Dry off high cell count cows when possible, to reduce BMSCC

Discussion on farm led to the agreement of immediate implementation of the following:

AGREED GOALS:

Hygiene:
- Apply fresh sawdust to the cubicles more frequently, aiming for 3-4 times a week initially
- Clip tails and flame udders every 2 months
- Increase contact time with pre-milking teat disinfectant in robot
- Manual scrape of passageways to 'mop up' what auto scraper leaves behind

Mastitis Protocols:
- Distinguish between cows with high cell count and cows with mastitis and follow the treatment protocol for each one (see figure 5)
- Use an anti-inflammatory when treating cows with mastitis.

Figure 5: Farm Protocol for Treating Cows with High Conductivity Alerts
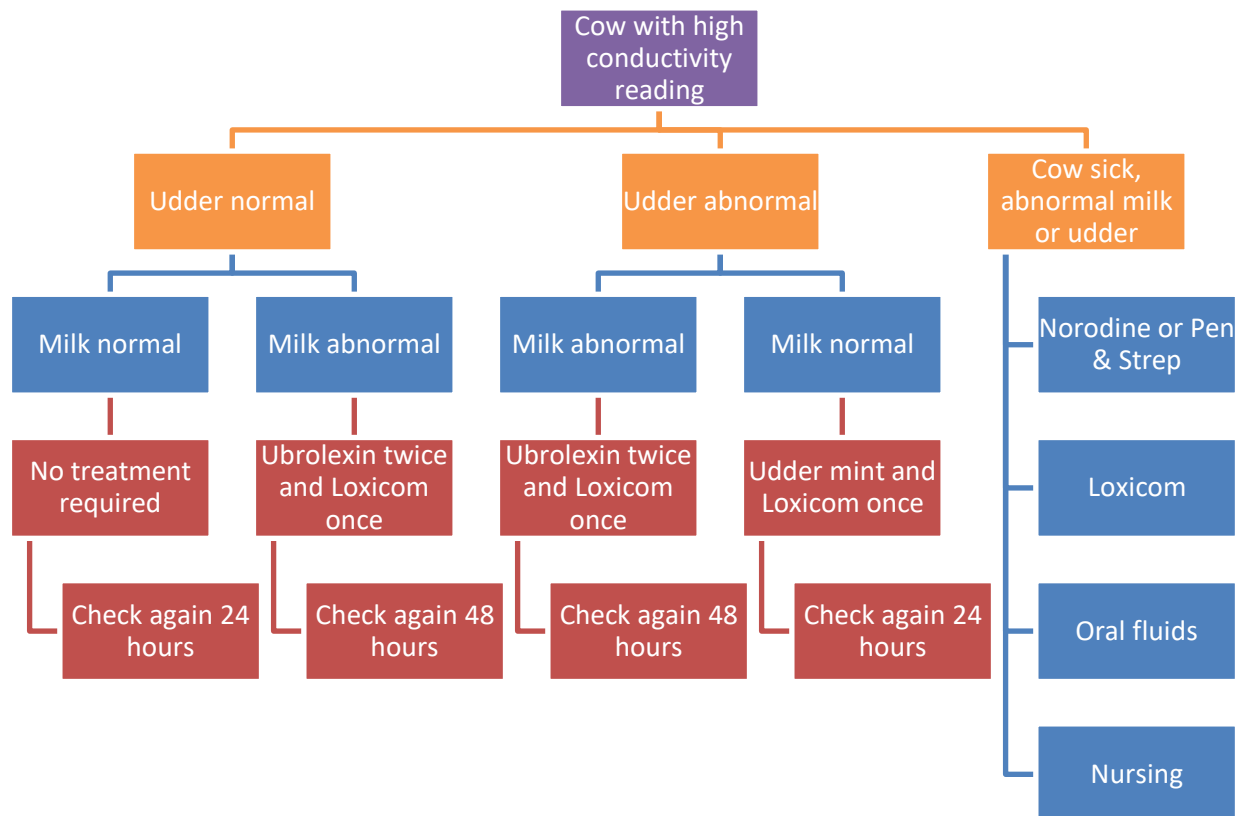
```
                        Cow with high
                         conductivity
                           reading
        ┌───────────────────────┼───────────────────────────┐
   Udder normal            Udder abnormal              Cow sick,
                                                     abnormal milk
                                                        or udder
   ┌──────┴──────┐        ┌──────┴──────┐
 Milk normal  Milk abnormal  Milk abnormal  Milk normal    Norodine or Pen
                                                               & Strep
 No treatment  Ubrolexin twice  Ubrolexin twice  Udder mint and
  required      and Loxicom      and Loxicom     Loxicom once    Loxicom
                   once             once
                                                              Oral fluids
 Check again 24  Check again 48  Check again 48  Check again 24
    hours           hours           hours           hours       Nursing
```

Monitoring and recording:
➢ Cows with high conductivity should not be recorded as clinical mastitis cases
➢ Monitor mastitis and cell count records every three months

Other:
➢ To dry off cows giving more than 15 litres, reduce feed in the robot and reduce visits to the robots in the period leading up to drying off

The remaining suggested actions were not possible immediately and were listed for consideration at the three-month review.

IMPLEMENTATION OF THE PLAN: FIRST REVIEW, FEBRUARY 2021

Udder health data was reviewed remotely in February 2021 due to the national lockdown, and an online meeting with the farm staff discussed progress on agreed goals.

Key Performance Indicators

All KPIs for udder health were improved as compared with October 2020. BMSCC was static until January (294,000 cells/ml) but fell to 121,000 cells/ml in February.

Clinical mastitis rate had decreased to 26 cases/100 cows/year for the last quarter (12 cases/100 cows/year for the previous month). Lactation new infection rate had fallen below target for the first time since recording started (4.4% for the last quarter, 3.1% for the last month). Dry period new infection rate was stable over the quarter but reduced to 14.3% for the previous month. Chronic infections were reduced from 22.7% to 8.6% (last month)/11.1% (last quarter); and percentage of infected cows in the milking herd from 35.2 to 12.9 (last month)/17.2 (last quarter).

Mastitis Pattern Analysis indicated that the predominant current issue was EDP with EL as the predominant recent issue.

Analysis of Progress

The most significant indicator of improvement was the fall in lactation new infection rates, since these fell below target for the first time since milk recording started. This directly reflected improvements in lactating cow management since it was unaffected by treatment or culling decisions.

Some of the stale cows had been dried off leading to the dramatic reduction in percentage of chronic cows and cows above 200,000 cells/ml.

Both of the factors above resulted in the decrease of the BMSCC below penalty levels. The lack of obvious improvement in the dry period new infection rate was unsurprising as this area was not targeted in the farm management plan. Three recent cases of clinical mastitis in the first thirty days of milk also highlighted the need to address dry period infections.

Progress on Agreed Goals

The farm implementation plan had fully achieved the following:

Hygiene:
➢ Apply fresh sawdust to the cubicles more frequently, aiming for 3-4 times a week initially – **in place**
➢ Clip tails and flame udders every 2 months - **in place**
➢ Increase contact time with pre-milking teat disinfectant in robot - **done**
➢ Manual scrape of passageways to 'mop up' what auto scraper leaves behind - **in place**

Mastitis Protocols:
➢ Distinguish between cows with high cell count and cows with mastitis and follow the treatment protocol for each one - **in place**
➢ Use an anti-inflammatory when treating cows with mastitis - **in place**

Monitoring and recording:
➢ Cows with high conductivity should not be recorded as clinical mastitis cases - **in place**
➢ Monitor mastitis and cell count records every three months - **ongoing**

Other:
➢ To dry off cows giving more than 15 litres, reduce feed in the robot and reduce visits to the robots in the period leading up to drying off - **done**

Recommendations

The new farm goals were:

Lactation
➢ Increase fresh sawdust application to the cubicles to <u>every day</u>
➢ Use lime as a bedding conditioner
➢ Avoid housing sick cows in the calving yard

Dry Period
➢ Look only at the previous three months of cell count data when deciding whether to use antibiotic at drying off
➢ Dry cow environment should be managed to as high a standard as lactating cow environment i.e., scraped daily and new sawdust applied
➢ The current dry cow feeding space is suitable for a maximum of 10 animals. If more than 10 dry cows are in the cubicle yard, more feed space must be opened up.
➢ Apply fresh straw to the calving yard daily

IMPLEMENTATION OF THE PLAN: SECOND REVIEW, JUNE 2021

A farm visit took place to review udder health data and observe and discuss changes resulting from the farm management plan.

Key Performance Indicators

Udder health indicators showed improvements in BMSCC, clinical mastitis and dry period new infection rate. BMSCC was well below 200,000 cells/ml for the last quarter (range 127-160,000 cells/ml). There had been only four cases of clinical mastitis since February (two dry period origin, two lactation origin) and so the clinical mastitis rate was down at 12 cases/100 cows/year (last month) or 8 cases/100 cows/year (last quarter). Dry period new infection rate was 0% in June, 14.3% in the last quarter.

There was some deterioration in lactating cows, with lactation new infections increasing to 7.5% (last month) / 8.4% (last quarter). Chronic infections were at 10.9% (last month) / 9.1% (last quarter); and 16.3% of milking cows had high cell count on the day of recording.

Mastitis Pattern Analysis indicated the predominant current issue was EL, with predominant recent issue EDP.

Analysis of Progress

Dry cow management had changed substantially as dry cows were now housed in the same cubicle area as lactating cows (in a separated section at the end of the shed). This resulted in equivalence of management in terms of bedding and scraping frequency; feeding and pushing up feed. Also, fewer cows calved during this period (compare 14 cows calving in January and February with 7 cows calving in March and April). The dry cow udder health had improved significantly as a result of all these factors.

The calving yard was still being used for sick cows as there was no suitable alternative site available. In the long term, the goal was to build a sick pen which has access to the robots. In the short term, the recommendation was to increase the amount of bedding, the bedding frequency, the mucking out frequency and reduce the stocking density.

The lactating cow environment had increased stocking density due to the addition of the dry cows. Increased bedding frequency had not been achieved and was still at a level of four times per week. However, feed was now being pushed up five times per day to help reduce busy times at the robots and also to allow for the reduced feed barrier space.

Recommendations

BMSCC improvement had resulted in reinstatement of the Arla 360 contract. The remaining two non-compliances related to 12-month historical averages.

Excellent progress on dry cow environment had been at some expense to milking cow environment. Continued attention to scrupulous hygiene of both housing areas was needed.

Selective dry cow therapy could now be increased by raising the threshold for antibiotic therapy to 200,000 cells/ml (previously 150,000 cells/ml).

IMPLEMENTATION OF THE PLAN: ANNUAL REVIEW, SEPTEMBER 2021

A farm visit and discussion concluded the first year of the Mastitis Control Plan.

Key Performance Indicators

KPIs for udder health had deteriorated across the board over the summer (see Table 3). Farm staff noted that this was the time of year when it was most difficult to maintain a suitable housed environment and that it was usual to experience increased cell counts and mastitis during this season.

Table 3: Udder Health KPIs at September 2021

	Oct 2020	3 month rolling average	12 month rolling average	Target
BMSCC	227	233	213	<200
Lactation New Infection Rate	11.4	9.5	7.7	<5
Dry Period New Infection Rate	33.0	24.1	22.8	<10
Dry Period Cure Rate	100	61.5	77.8	>85
% herd chronically infected	14.1	11.8	12.7	<5
% herd >200,000 cells/ml	27.2	22.8	20.8	<20
Clinical Mastitis cases/100 cows/year	21	35	31	<25

All udder health parameters had worsened since June, but were still improved compared to a year previously, with the exception of dry period new infection rate, which was the same as in October 2020.

The deterioration was accounted for by two major challenges that had occurred in 2021, alongside the usual summer environmental conditions. Firstly, supplies of shavings were temporarily interrupted and bedding frequency and amount were both significantly reduced in July and August as a result. Secondly, high numbers of cows calving (28 in July and August) produced pressure on first the dry cow cubicles, then the calving yard and finally the lactating cubicle environment.

Mastitis Pattern Analysis indicated the predominant current issue was EL.

Cell Count Performance

The rate of new infections in lactation began to increase in April, as noted in the June review, and continued to climb through the summer with the highest rate in September (11.4%) (see figure 6). This resulted in increases in BMSCC, and the percentages of chronic cows and high cell count cows.

Figure 6: Lactation New Infections to September 2021
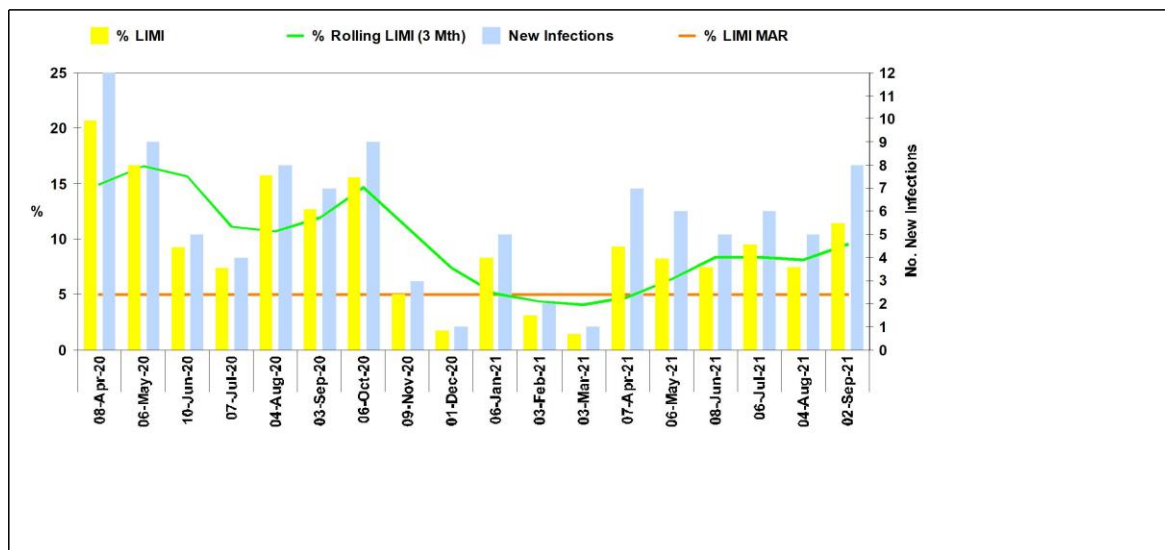
Dry period new infections also increased (see figure 7); although the rate fluctuated from month to month it was always above target. The reader should note the high numbers of cows calving in the summer. Dry period cure rate did not achieve the desired levels, but as before this most likely reflects reinfection.

Figure 7: Dry Period New Infections to September 2021
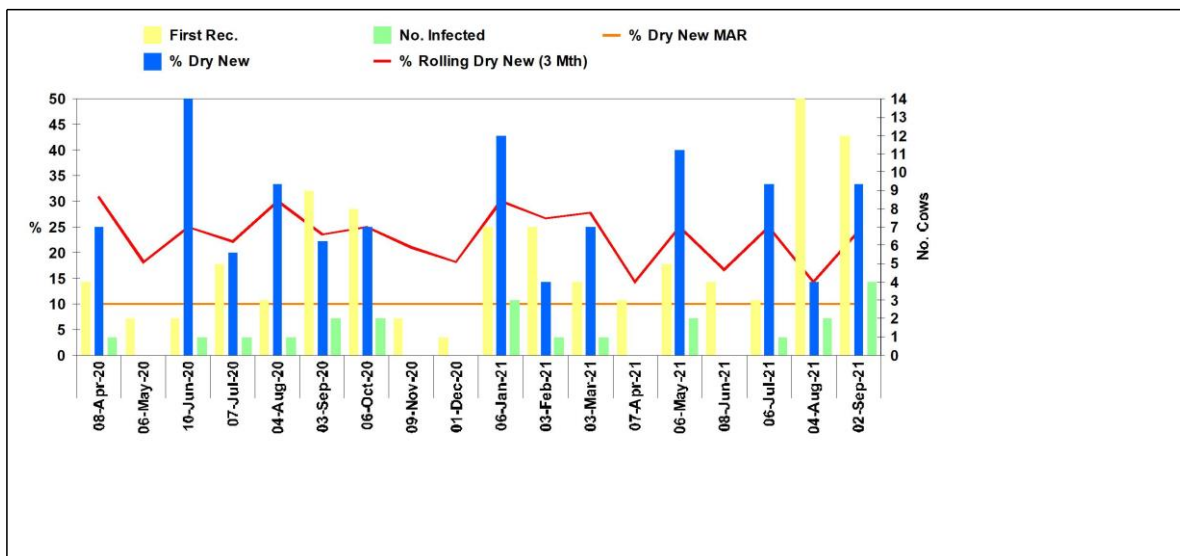
Clinical Mastitis Performance

Cases of clinical mastitis in lactation increased, starting in May and peaking in June (see figure 8), reaching above target levels for the quarter. There was one case of dry period origin mastitis in the summer. Apparent cure rates were good with no lactational recurrent infections.

Figure 8: Clinical Mastitis to September 2021
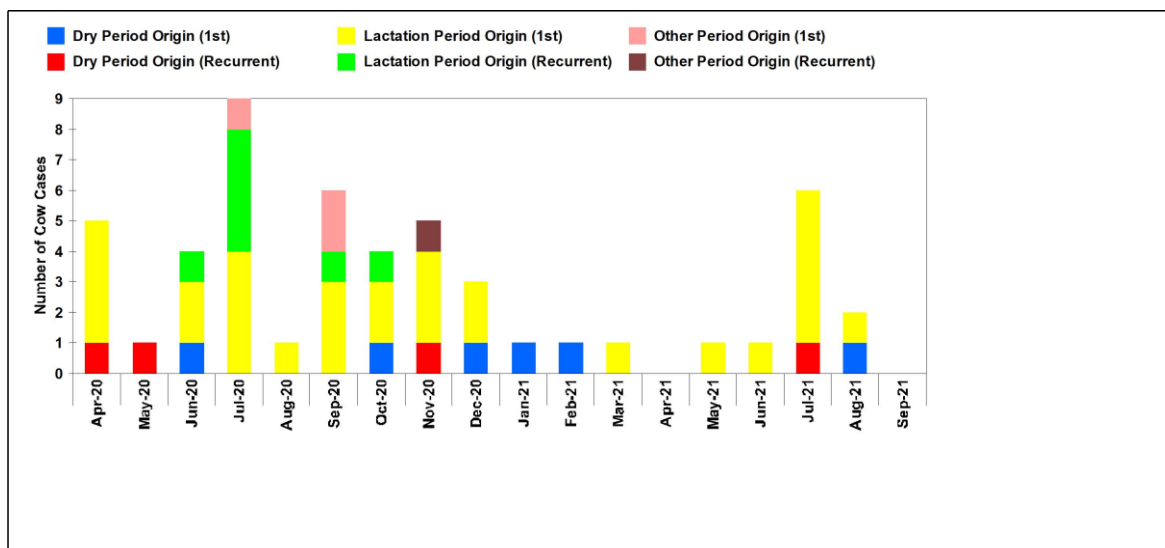
Recommendations

The farm management were well aware of the deteriorating situation and the major causes. Supply of shavings had resumed and bedding-up was occurring

at the previous rate (six times per week). The expected calving pattern indicated small numbers of cows calving until January 2022, when eleven cows were due.

Recommendations for ongoing management were as follows:

➢ Return to the previous high level of environmental hygiene in cubicle housing
➢ Arrange an additional calving area for January so that peaks in calving can be accommodated
➢ Chronic high cell count cows should either be dried off or have a quarter dried off
➢ Collect aseptic pre-treatment milk samples from clinical mastitis cases to assess bacteriology for surveillance purposes

CONCLUSION

The case report presented here exemplifies both the success that can be achieved by engaging with the AHDB MCP, and the challenges associated with maintaining high standards in one area of farm management, either when beginning to focus on other areas, or when dealing with short term system failures such as too many cows calving or material supply issues.

Also illustrated is the beneficial impact of the ambitious targets of some milk contracts, since the client involved would not deny that they were motivated to change solely by the need to retain their contract, but neither would they deny the obvious benefits to cattle health, welfare and productivity they have observed as a result of their farm management improvements.

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UDDER HEALTH PARAMETERS IN UK DAIRY HERDS UNDER DIFFERENT MANAGEMENT SYSTEMS

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The AHDB Sentinel Herds Project provides an annual overview of udder health parameters in a cohort of well recorded herds, with reliable clinical mastitis records and regular individual cow somatic cell counts. The distribution of herds reflects the national population. A group of 98 herds supplied data for 2020, summarised in Table 1.

Table 1 Key farm indices and udder health indicators

Variable	N	Mean	Median	SE mean	Min	Max
Herd size	98	361	275	31.9	64	1789
Mean annual rolling 305 day yield (l)	96	8945	8919	204	4618	13181
Calculated bulk milk SCC (,000/ml)	94	161	153	5.5	56	305
Clinical mastitis (CM) rate (cows affected /100 cows/ year)	98	29.7	25.5	1.78	4	90
Dry period origin CM rate (cows in 12)	98	0.64	0.56	0.05	0	3.2
Lactation origin CM rate (cows in 12)	98	1.91	1.73	1.10	0.31	5.44
Lactation new infection rate (%)	96	6.57	6.1	0.275	2.3	14
Dry period new infection rate (%)	96	15.5	14.0	0.70	2.7	38
Dry period cure rate(%)	95	77.4	79.5	1.31	31.3	100
Fresh calver infection rate (%)	96	16.8	15.1	0.78	4	42.1
% chronically infected	96	8.73	8.25	0.419	0.9	19.7
% > 200,000 cells/ml	96	15.6	14.6	0.591	4.3	31.5

Herds were classified on calving pattern and housing policy for milkers and calving cows, from information collected by telephone. In 62 herds, the main group of milkers grazed for at least 4 months and in 31 herds all milkers were continuously housed. Grazing herds were further divided by whether the majority of cows calved indoors or outdoors (Table 2). The relationship between management system and udder health parameters was investigated.

Table 2. Definition of management systems used for analysis

Milkers	Graze *	Graze*	Graze*	Graze*	Continuously housed
Calving	Year round Outside	Year round Inside	Block Inside	Block Outside	Year round Inside
Code and n	GAO 13	GAI 15	GBI 19	GBO 12	HAI 31
* the majority of milkers grazed for at least 4 months of the year					

Following initial univariable analysis, the effects of yield, calving pattern and housing of milking cows and calving cows on various udder health parameters were explored with multivariable linear models. When yield was taken into account, incidence of clinical mastitis was significantly higher when milkers grazed and calved all year round outside, compared with other systems. This was largely driven by higher rates of mastitis of dry period origin - possibly linked to outdoor calving (Table 3). Management system had very little effect on SCC parameters once yield was taken into account.

Table 3. Models of clinical mastitis rates

Clinical Mastitis Cases per 100 cows per year			Dry Period Origin Cows in 12		Lactation Origin Cows in 12	
	Estimate	SE	Estimate	SE	Estimate	SE
Intercept	49.9	10.9	1.51	0.289	2.86	0.68
Yield (,000l/cow/year)	-0.58	1.17	-0.05	0.03	-0.04	0.07
GAO	Reference					
GAI	-14.3 *	6.21	-0.43 *	0.16	-0.36	0.38
GBI	-24.8 ***	6.01	-0.60 ***	0.16	-1.20 **	0.37
GBO	-19.3 **	6.64	-0.36 *	0.18	-1.05 *	0.41
HAI	-14.5 *	6.10	-0.52 **	0.61	-0.38	0.38
* P< 0.05, ** P<0.01, ***P<0.0001						

The Sentinel Herd data demonstrated differences in clinical mastitis rates between systems, but these associations do not necessarily mean causal relationships.

ACKNOWLEDGEMENTS

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