BRITISH MASTITIS CONFERENCE 2024

Wednesday 12th June 2024
Pitchview Suite, Sixways Stadium, Warriors Way, Worcester, Worcestershire, WR3 8ZE

Organised by

The Dairy Group	British Cattle Veterinary Association	The University of Nottingham UNITED KINGDOM · CHINA · MALAYSIA	QMMS

Topics:

- Mastitis research review and the future
- Udder health in automated milking systems
- Knowledge transfer & Research updates
- Managing mastitis in a spring calving herd
- Challenges of chlorine-free cleaning of milking equipment
- A mastitis control case study

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TABLE OF CONTENTS

General information	
Table of Contents	i
Chairman's Introduction	ii
Timetable of Events	iii
Titles of Papers and Presenters	iv
Titles of Posters and Authors	v - vii
Further Information	viii
Sponsors	ix
National Mastitis Council	x

CHAIRMAN'S INTRODUCTION

Welcome to the 2024 and 36th British Mastitis Conference at Sixways Stadium, Worcester.

As always, the organising committee has been guided by delegate feedback and we believe that we have brought together a group of speakers from the UK, Ireland and New Zealand which will provide interesting, thought provoking and stimulating presentations. As ever, we have tried to have struck a balance between up-to-date research results and practical presentations with clear take home messages.

The first paper reviews mastitis research while looking forward at what the future may hold for our industry. This will be followed by a paper on practical management of udder health in automated milking systems. 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.

Now a staple of BMC, we have selected four posters from the Knowledge Transfer / Research Update section for oral presentation. The four papers are followed by an opportunity for delegates to debate with each of the presenters.

After lunch there will be a presentation on managing mastitis with a spring calving herd. This is followed by a paper on meeting the challenges of chlorine-free cleaning of milking equipment. The final paper at BMC 2024 will be the ever-popular Mastitis Control Plan case study.

This year we have seen another increase in the number of submitted posters with several "new faces" presenting. The thirteen posters cover a wide range of topics with the common theme of improving the mastitis levels in dairy cows together with overall milk quality. Please make time to review the posters and speak with the authors. Thanks to all poster presenters who have 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 (Gold), Mastatest (Gold), ATL Agricultural Technology Limited (Gold), DairySmart New Zealand (Gold), DeLaval (Silver), Boehringer Ingelheim (Silver), Milkrite I InterPuls (Silver), ADF Milking Limited (Silver), Zoetis (Silver), Ambic (Bronze) and Oxi-Tech Solutions Ltd (Best 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 37th BMC in 2025.

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	**Brian Pocknee** DHC, Spain
09.55	Review of mastitis research and what does the future hold?	**Eric Hillerton** Cambridge, New Zealand
10.30	Practical management of udder health in automated milking systems	**Tom Greenham** Advanced Milking, UK
	Session Two **Research Updates / Knowledge Transfer (also presented as posters)**	**Elizabeth Berry** BCVA; UK
11.40	Use of mastitis pattern analysis reports to monitor udder health on UK dairy farms	**Al Manning** QMMS Ltd, UK
12.00	Exploring udder cleft dermatitis: cow specific contributors revealed!	**Rosa Ana Puentes Garrido** University of Liverpool, UK
12.20	Comparison of two selective dry cow therapy protocols	**Ben Davidson** DairySmart, New Zealand
12.40	Trends in cattle intramammary tube usage over recent years in Great Britain	**Judith Roberts** Map of Ag, UK
13.00	**LUNCH & POSTERS**	
14.10	**WELCOME BACK & VOTING ON POSTERS**	
	Session Three	**Brian Pocknee** DHC, Spain
14.15	Reducing somatic cell count in a spring calving herd	**Jonny Slack** Dolphenby Farm, UK
14.50	Meeting the challenges of chlorine-free cleaning of milking equipment	**David Gleeson** Teagasc, Ireland
15.25	Implementation of the AHDB dairy mastitis control plan: reducing environmental infections and clinical mastitis incidence rate	**James Breen** University of Nottingham, UK
16.00	**POSTER AWARD**	
16.05	**CLOSE**	

Titles of Papers and Presenters

Session One	
Review of mastitis research and what does the future hold? Eric Hillerton, Cambridge, New Zealand	1 – 10
Practical management of udder health in automated milking systems Tom Greenham, Advanced Milking	11 – 20
Session Two **Research Updates / Knowledge Transfer (also presented as posters)**	
Use of mastitis pattern analysis reports to monitor udder health on UK dairy farms Al Manning, QMMS Ltd	21 – 22
Exploring udder cleft dermatitis: cow specific contributors revealed! Rosa Ana Puentes Garrido, University of Liverpool	23 – 25
Comparison of two selective dry cow therapy protocols Ben Davidson, DairySmart	27 – 28
Trends in cattle intramammary tube usage over recent years in Great Britain Judith Roberts, Map of Ag,	29 – 31
Session Three	
Reducing somatic cell count in a spring calving herd Jonny Slack, Dolphenby Farm	33 – 40
Meeting the challenges of chlorine-free cleaning of milking equipment David Gleeson, Teagasc	41 – 48
Implementation of the AHDB dairy mastitis control plan: reducing environmental infections and clinical mastitis incidence rate James Breen, University of Nottingham	49 - 62

Titles of Posters and Authors

Poster Abstracts – presented as Posters on the Research Update / Knowledge Transfer Display Panels (Presenting author underlined)	
Revision of ISO Standards for milking machines John Baines[1], Carl Oskar Paulrud[2], Daniel Hedlund[3] [1]Milking Equipment Association, Samuelson House, 62 Forder Way, Hampton, Peterborough PE7 8JB, UK; [2]Delaval, Gustaf De Lavals väg 15, 147 41 Tumba Sweden; [3]Daniel Hedlund, Swedish Institute for Standards, SIS Box 45443, SE-104 31 Stockholm, Sweedon. Email: j_baines@live.co.uk	63 - 65
Investigations into the effects of the duration of the c-phase of pulsation in milking performance Douglas J. Reinemann[1] and Carl Oskar Paulrud[2] [1]University of Wisconsin Milking Research and Instruction Lab, Madison, WI, 53706, USA; [2]Delaval, Gustaf De Lavals väg 15, 147 41 Tumba Sweden. Email: djreinem@wisc.edu	66 – 68
A practical approach to the selective treatment of clinical mastitis (STCM) Judith Roberts Map of Ag. Suite 1a Gilwilly Road, Gilwilly Industrial Estate, Penrith, Cumbria CA11 9FF, UK. Email: jude.roberts@mapof.ag	69 – 71
Bacterial species prevalence in clinical mastitis samples: an analysis of data over two years S. Saila and Olaf Bork Mastaplex Ltd, 87 St David St, Dunedin 9016, New Zealand, Email: info@mastatest.com	72 – 73
Freezer storage impact on clinical mastitis culture results Rowan Cook[1,2], Joana Lima[1], Jolinda Pollock[1], Richard J. Dewhurst[1], Sharon Huws[2], Chris J. Creevey[2] and Holly J. Ferguson[1] [1]Scotland's Rural College, Peter Wilson Building, Edinburgh, EH9 3JG, UK; [2]Queen's University Belfast, School of Biological Science, BT9 5DL, UK. Email: rowan.cook@sruc.ac.uk	74 – 76
Trends in dairy herd antimicrobial usage: from the lowest users to the highest Kathryn Rowland[1], Christina Ford[1], Emma Puddy[1] and Tim Potter[2] [1]Kingshay, Bridge Farm, West Bradley, Glastonbury, Somerset, BA6 8LU, UK; [2]Westpoint Farm Vets, Dawes Farm, Bognor Road, Warnham, West Sussex, RH12 3SH, UK. Email: kathryn.rowland@kingshay.co.uk	77 - 79

Titles of Posters and Authors Continued

***E. coli* and *Pseudomonas aeruginosa:* microbiological testing of Oxi-Tech Solutions' pulse oxidation cell ozone system** S. Price. Presented by Luke Bixler Mercian Science Laboratory, Lichfield WS14 9TZ, UK. Email: lukeb@oxitechsolutions.com	80 – 81
Testing Oxi-Tech Solutions pulse oxidation cell ozone system's impact on a P*seudomonas aeruginosa* biofilm S. Price. Presented by Luke Bixler Mercian Science Laboratory, Lichfield WS14 9TZ, UK. Email: lukeb@oxitechsolutions.com	82 – 84
Measuring the impact of key udder health parameters on dry period cure rate Ian Glover[1,2], A. Manning[1], K. Leach[1] and A.J. Bradley[1,2] [1]Quality Milk Management Services Ltd, Cedar Barn, Easton, Wells, BA5 1DU, UK; [2]School of Veterinary Medicine and Science, University of Nottingham, Sutton Bonington Campus, Sutton Bonington, LE12 5RD, UK. Email: ian.glover@qmms.co.uk	85 - 86

Titles of Posters and Authors Continued

Poster Abstracts – oral presentation in the Research Update / Knowledge Transfer Session and as Posters on the Display Panels	
Use of mastitis pattern analysis reports to monitor udder health on UK dairy farms Al Manning[1], K. Leach[1], K. Bond[2], J. Mathie[3], J. Thompson[4], R. Hyde[4], L. O'Grady[4], M. Green[4] and A.J. Bradley[1,4] [1]Quality Milk Management Services Ltd, Cedar Barn, Easton, Wells, BA5 1DU, UK; [2]National Milk Records Ltd, Greenways Business Park, Fox Talbot House, Chippenham, Wiltshire, SN15 1BN, UK; [3]The Cattle Information Service Ltd, 9 Queens Road, Aberdeen, AB15 4YL, UK; [4]School of Veterinary Medicine and Science, University of Nottingham, Sutton Bonington Campus, Sutton Bonington, LE12 5RD, UK. E-mail al.manning@qmms.co.uk	21 -22
Exploring udder cleft dermatitis: cow specific contributors revealed! Rosa Ana Puentes Garrido, A. Gillespie, R. Ridgway, K. Ogden, and H. Williams Livestock and One Health, Institute of Infection, Veterinary and Ecological Sciences, University of Liverpool, Chester High Road, Neston, CH64 7TE, UK. Email: R.A.Puentes-Garrido@liverpool.ac.uk	23 – 25
Comparison of two selective dry cow therapy protocols **Ben Davidson[1] (presenting on behalf of Winston Mason[2], Emma Cuttance[2], Richard Nortje[3] and Richard Laven[4])** [1] Dairysmart NZ Ltd, Rangiora 7471, New Zealand; [2] Epivets Ltd, 565 Mahoe Street, Te Awamutu 3800, New Zealand; [3] Rangiora Vet Centre, Rangiora 7471, New Zealand; [4] Massey University, Palmerston North, 4442, New Zealand. Email: CEO@dairysmart.co.nz	27 – 28
Trends in cattle intramammary tube usage over recent years in Great Britain Judith Roberts Map of Ag. Suite 1a Gilwilly Road, Gilwilly Industrial Estate, Penrith, Cumbria CA11 9FF, UK. jude.roberts@mapof.ag	29 - 31

FURTHER INFORMATION

Organised by *The* Dairy Group, BCVA, QMMS and University of Nottingham

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NMC

A global organization for mastitis control and milk quality

The 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 nearly 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
- 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
- Offers a Scholars program for graduate students

A commitment to reducing mastitis and enhancing milk quality

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 dairy producers, veterinarians, university researchers and extension specialists, milk procurement field staff, equipment and supply representatives, government 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, containing all of the papers and posters presented at the meetings
- NMC electronic newsletter, addressing 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, NMC membership directory, and NMC Job Board
- Opportunities to network with other dairy professionals concerned with milk quality

No other professional dairy organization enjoys the wide range of expertise found within the NMC membership.

Working together

Since 1961, NMC has coordinated research and education 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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Proceedings of the British Mastitis Conference (2024) Sixways, Worcester, p 1 - 10
The Dairy Group, The University of Nottingham, BCVA & QMMS

REVIEW OF MASTITIS RESEARCH AND WHAT DOES THE FUTURE HOLD?

J. Eric Hillerton[1] & Elizabeth A. Berry[2]
[1]Cambridge, New Zealand; [2]Ross-on-Wye, UK. Email: hillerton@outlook.com

OUR THINKING

To start, here are two things we have learned about dairy farming, they are probably quotes from others:

"Cows don't give us abundant wholesome milk" and

"We have to work hard and diligently, applying many key learnings to be successful for us and, especially, the cow".

Our fixation in mastitis research has always been on what is beneficial to the cow, and some for the farmer. In a combined 75+ years of mastitis research we have gained personal experience or worked with others in virtually every aspect of research. It did not take us long to realise that decades of effort, then and now, have been dedicated to infection and disease and rarely has a main focus been on health. What follows are some thoughts on what may have worked, some on areas that have consumed time and resources way beyond any possible value, and some areas that were never going to provide anything of value to the cow. We will finish with some new stuff from a series of trials and studies that suggest we may, at last, get real progress in using genetics to manage mammary gland health rather than mastitis.

WHAT HAS RESEARCH IN THE PAST 10 YEARS CONTRIBUTED (OR NOT)?

This review actually starts from the 1975 International Dairy Federation (IDF) symposium in Reading which had 48 paper presenters, five are still alive but none have produced anything on mastitis in the last 10 years or more. The 1985 IDF symposium in Kiel had 59 paper presenters, 19 are still alive but only one has published on mastitis in at least the past five years.

Similar topics were identified at both IDF meetings for future work. These are compared in Table 1 with a 2011 review of mastitis research needs (10). Simply, many of the priorities identified over the decades apply equally now. Why, has so little been achieved? But then many topics have been or should have been revised.

Simply, we have seen some huge successes, based on research, where *the adverse effects of the milking machine have largely disappeared*, when it is managed well; with use of an adequately sized claw bowl, a wide enough short milk tube, simultaneous pulsation; and many advances in liners. Automated milking has pushed the advances and benefits further, only limited by the time, often long, taken to learn how to use these systems.

Table 1 Some simple topics identified at IDF 1975 and 1985, in the 2011 review (10) and now with shaded boxes those matters considered here (limited only by time).

AREA	1975/1985	2011	2024
Socio-economics	-	All about gathering cow data, herd modelling	Generic and local
Control programmes	5-point plan adoption agreed, +/- dry cow antibiotics	Vary the 5-point plan according to geography, system and politics	Complicated but machine, culling and teat dipping largely unchallenged
Milking machine	Advances needed agreed	Adoption of many advances	No major engineering issues
Environment	Coliforms and bedding; summer mastitis and flies	Local, system	Almost farm by farm
Pathogens	Missing *Str. uberis* epidemiology	Round in circles, Little experimentation	Culture negative samples and the biome
Diagnostics	Bacti+SCC, milk chemistry	New tests and sensors	Cost versus value
Therapy	Still a Staph gap, resistance not considered	Targeting treatment to pathogen	Limit antibiotic use.
Immunology	Good but cow variation, IMD, PMN ‘Mastitis to cure mastitis’	Waiting for effective vaccines	Still waiting
Genetics	Cannot ‘measure’ resistance so natural selection	None	Watch this space
Overall		All lab and little farm	Technologies and modelling and little consideration of the cow. Public health significance

Teat dipping (done properly) remains an absolute essential, although we doubt the newer dips themselves have delivered much better effects.

Culling continues to serve us well, mostly for Staph cows.

Antibiotics have generally been beneficial (mostly in dry cows) and thank goodness for teat sealants now that Britain has joined much of the rest of Europe in restricting use of dry cow products, although this has never been on any research priority list.

However, we suggest what all this tells us is a continuing focus on dealing with the consequences of infection and disease, the things that have occurred when we have failed to maintain a healthy udder. This is the antithesis of the highly successful work of 60 years ago to prevent and eliminate infection. It remains to be seen what the effects of stopping prophylactic use of intramammary antibiotics have over all farm systems. It may mean the next target of selective therapy for clinical mastitis has a much higher priority. Internationally this is a developing vogue, targeting treatment towards specific pathogens when possible is considered necessary for rational antimicrobial treatment of mastitis, as should be the case in all treatment of bacterial infections. Time is too limited to deal with this, a topic for next year? See de Jong et al. (11) to start you thinking on this topic; it could be a major contributor to reducing antimicrobial use in dairy cows, which is an area lagging other veterinary use.

THREE BUGBEARS AS EXAMPLES OF WHAT WE FIND FRUSTRATING, LACKING IMAGINATION AND DOWNRIGHT MISSING ANY TRUE RELEVANCE TO MASTITIS MANAGEMENT

Teat models

A number of years ago work reported at this conference led the way in describing the importance of teat condition in cow welfare and udder health. The methods developed continue in use worldwide. Recently, a number of results in literature searches have revealed various, apparently unpublished, studies (4, 6) using technologies such as convoluted neural networks to examine teat features from images. The results fell short of the set target accuracy, i.e. the technology does not work, yet it is claimed the projects 'could have a significant impact on the dairy sector'. This work was done using very old literature images by people who appear never to have been on a farm, and from their reports (available by web searches and apparently never peer-reviewed) know little about why they want to determine teat condition. We despair on how much time and scarce research money is wantonly wasted chasing new science of minimal potential for us who milk cows.

Mammary gland biome

A little over 10 years ago was the start of a considerable number of publications reporting that new techniques in molecular biology were identifying considerably more bacteria, or markers of those bacteria, in milk from the dairy cow than any milk culturing techniques could reveal. These included bacteria never before known from 'sterile' milk, e.g. *Trueperella pyogenes* (15), bacteria well known to cause severe disease and even death, when experimentally introduced into the lactating gland and in on-farm cases.

The conclusions of the lab scientists led to the concept of "commensal mammary microbiota" (3) with little or no hypothesising on what the bacteria were doing in the udder. The tens of studies published ignore that the findings may be a technological artefact. No direct evidence has been produced that these findings relate to living bacteria.

One challenge (8) was that, over decades, we have learned a lot about infections of the mammary gland of dairy cows from experimental investigations of the pathogenesis of the various diseases. The understanding gained has contributed to huge successes in reducing the prevalence of infection in properly managed dairy herds. Now descriptive studies using DNA technologies reject previous concepts of mammary gland sterility by default. No direct evidence exists because experimental studies of infection are no longer fashionable.

The mammary gland immunologist Pascal Rainard of INRA was a key part of in refuting this new concept. In an elegant disposition he argued "the logical implications of this paradigm shift show how this concept is incompatible with current knowledge concerning the innate and adaptive immune system of the mammary gland of dairy ruminants. It also highlights how the concept of mammary microbiota clashes with results of experimental infections induced under controlled conditions or large field experiments that demonstrated the efficacy of the current mastitis control measures" (16).

And later (17), 'The problem with the current stream of 'omics' studies on mastitis is that there is often no visible attempt or even commitment to doing experiments that might produce evidence consistent or inconsistent with the hypothesis generated by the analysis of the data. The desire to understand and acquire new knowledge is difficult to perceive in many studies, and the motivation seems to be only the possibility of publishing articles in specialized 'omics' journals which often have a good impact factor, due to cross-citations of so many publications, a foaming effect."

Several colleagues from the mastitis research world have shared experiences that when asked to review such manuscripts and recommending rejection (sometime by two or three reviews of three requested) the manuscript has still been published.

To stir things, we add that the proponents of the extensive biome appear to have missed the huge body of work from 1982, although the ideas have much earlier origins, that bacteria can exist in a viable but non culturable state, sometimes induced by environmental influences and able to be resuscitated although the morphology of these VBNC bacterial cells are virtually indistinguishable from dead cells (13). A kind of Norwegian blue of mastitis-causing bacteria!

(Lack of) experimentation

A regeneration of the lost arts in the pathogenesis of infection is essential to separate truth from conjecture and deal with coming challenges from spurious application of new technologies without supporting evidence, rapidly changing farm systems and the reduction in access to antimicrobial drugs. We need a return to experimental approaches that construct hypotheses, and then test them, in intramammary health research. Rainard again (17): What is the consolidated cost of many inconsequential studies? He quoted Oscar Wilde, we cannot afford to overlook 'the importance of being earnest' with the use of research funds devoted to mastitis research.

Diagnostics

A key gap over many decades has been the failure to produce adequate real-time diagnostic sensors that compete effectively with the eyes, taste and touch of the human milker. We firmly believe that more money has been spent (we mean wasted) for the very least achievement, on sensors than any other aspect of mastitis control. Some 60 years ago field studies found that the milker found 70% of cases at the first milking, 70% of 30% at the next, and then the case was either blindingly obvious or had disappeared. Is this why a recent review on use of engineering to support wellbeing mentioned 31 commercial sensors covering six health conditions but not mastitis (2)? However, anecdotal observations from veterinary practices in the New Zealand South Island suggest a growth in use of diagnostics systems to detect clinical mastitis. This need is in herds of several hundred cows where there is growing selectivity on what clinical mastitis to treat, and when (see the review 11). It is a response to the drive to reduce antibiotic usage in food animals.

NOW FOR SOMETHING COMPLETELY DIFFERENT

It is almost exactly 40 years since that major devastation of agricultural research in the UK that saw a reduction in institutes from 32 to eight with the majority of research and researchers abandoned. At least one good thing came out of it, a new philosophy when the Institute for Research on Animal Disease, with the institutes at Houghton and Pirbright, evolved to become the Institute for Animal Health. Investigating infection and disease has remained important but the mindset of health was an essential philosophical change. We started to apply this to mastitis research.

Early in my time in New Zealand I became convinced of the need for a new strategy, so I wrote a stretch target concept note on 'The no mastitis herd'. The remainder of this talk will describe some of the thinking and research in the ambition to achieve a healthy mammary gland and continuing to deal with mastitic udders. After all the healthy cow is the norm in the herd. We have known for 70 years how to make a herd free of *Streptococcus agalactiae;* we made a herd free of *Staphylococcus aureus* 30 years ago (7). Today 50% and more cows never show signs of a mastitis in their life. The aim has been to get more of these, a positive (rather than fatalist) aim.

Study 1 (5)

Milk from some dairy cows never known to have had an intramammary infection with *Streptococcus uberis* was shown *to* inhibit growth of *Str. uberis* for up to 7 h. This inhibition is abolished if the milk is heated to 80 °C. Inhibition appears not to be related to immune defences as it occurs in skimmed milk (cell free), it is unrelated to the concentration of immunoglobulin and survives heating to 56 °C. The effect is partly overcome by addition of selected amino acids and vitamins. It is suggested that the inhibition is caused by a restriction in the supply of essential nutrients, part of which may require the conversion of plasminogen to plasmin. To understand more of this read papers by Jamie Leigh's group.

Milk from some cows has a means of slowing bacterial growth for a useful time after bacterial invasion, perhaps until the bacteria are milked out.

Study 2 (1)

Individual cow cell concentrations, even in uninfected cows, vary from day to day and this can be more than 40%, a blip induced that only lasts a day or two.

Some cows may be seeing a bacterial invasion of the mammary gland that is swiftly resolved.

Study 3 (18)

Cows used had either no apparent history of intramammary infection (IMI) by *Streptococcus uberis* or other major mastitis pathogens throughout their productive lifetime ('apparently uninfected'; AUI), or had a confirmed history of

Str. uberis IMI ('historically infected'; HI). Cows were exposed to *Str. uberis* in sequential steps: dipping of the teat end (DIP; n=53 cows); a teat canal inoculation (TCI; n=33 cows); and, finally, intramammary inoculation challenge (IC; n=7 cows). Only cows that remained free of infection at each step progressed to the next phase. Infection rates were similarly low between AUI or HI cows following the DIP (9 and 17% respectively), but similarly high with TCI (75 and 68% respectively). Analysis of traits prior to inoculations implied that HI cows produced more milk fat, while AUI cows tended to have longer teat canals. For cows that became infected following DIP, there was a positive association with milk fat production and a negative association with somatic cell count (SCC), and there was a negative association with SCC in those cows infected by TCI. A small proportion of cows was identified that remained uninfected after DIP, TCI and IC, and may comprise a resistant phenotype.

***The teat canal is the primary defence so maintain its integrity. Some cows in the herd are extremely difficult to infect with* Str. Uberis**

Study 4 (9)

In experimental infections, clinical mastitis with *Str. uberis* is more likely following invasion in the intermilking interval when no or little cisternal milk is around but the duct may have residual fat.

This is consistent with study 1

Study 5 (14)

Although the aetiology and epidemiology of mastitis in the dairy cow are well described, the genetic factors mediating resistance to mammary gland infection are not well known, due in part to the difficulty in obtaining robust phenotypic information from sufficiently large numbers of individuals. Thus, an experimental mammary gland infection experiment was undertaken, using a Friesian-Jersey cross breed F2 herd. A total of 604 animals received an intramammary infusion of *Streptococcus uberis* in one gland, and the clinical response over 13 milkings was used for linkage mapping and genome-wide association analysis. A quantitative trait locus (QTL) was detected on bovine chromosome 11 for *Str. uberis* clinical mastitis status and then exome and genome sequence data used from the sires to examine this region in more detail.

A total of 485 sequence variants were typed in the QTL interval, and association mapping, using these and an additional 37,986 genome-wide markers, revealed association with markers encompassing the interleukin-1 gene cluster locus.

A region on bovine chromosome 11, consistent with other published work but this time identifying a potential genetic influence, appears to confer resistance to experimentally induced Str. uberis infection.

Many countries have included selection for resistance to mastitis, or high cell count, in their breeding programmes, e.g. HealthyCow, but these are largely statistical and economic indices from herd records. The work described here differs because it investigates by experimentation the pathogenesis of infection and a potential genetic influence on resistance by the immune system rather than a population genetic (statistical) description.

Study 6 (12)

To test the understanding so far, the udder health of 808 heifers over two years, on one farm, created by six F1 bulls of high genetic merit (sires A to F), mated to F2 females was monitored. The data came from 23,996 quarter milk samples for bacteriological analysis, with 21,434 samples (90%) pathogen free. Clinical mastitis (CM) was 201 cases or 13.3% with *Str. uberis* (41%) of cases.

Daughters of sire A had the lowest risk of CM, with only 4.2% of animals experiencing CM, whereas daughters of sires D, E, C and B had a two to four-fold higher risk of CM ($R \geq 2.38$, $P < 0.013$), with incidences ranging from 9.5% to 16.6% of animals in a lactation.

A significant association was identified of sire with lactational average milk cell count ($P < 0.001$), such that daughters of sires A and C had the lowest lactational average SCC (52,000 cells/mL), and daughters of sires F and B the highest (73,000 and 84,000 cells/mL respectively).

Certain sires were consistently better than others in influencing a cow's ability to resist new infections following natural challenge.

Subsequently, the New Zealand Animal Evaluation data show that the Somatic Cell BV for sires A and C remains at -0.33 with >97.4% reliability, in contrast to sire B (0.83 at 96.5% reliability) with sires D, E, and F having intermediate figures (0.21, 0.38 and 0.47 respectively at > 95.9% reliability).

Study 7 (19)

Four SNP, identified in Study 6 were found to be significantly associated with mastitis phenotypes. To compare the mastitis phenotypes between studies the natural challenge data were reanalysed using logistic regression to test for any association of mastitis phenotypes with cohort.

The results indicate a similarity between the experimental infection results (Study 5) and the heifer field observations in Study 6. For example, SNP rs210625621 was significantly associated with whether cows had a CM in their first lactation (Cmbi_L1) in Study 6, and whether the animals in that independent population had any CM. Similarities were also apparent for intramammary infections (IMI). For example, SNP rs211043873 was significantly associated with whether cows in Study 6 were positive for a *Str. uberis* IMI at calving in the first lactation (i.e. while they were heifers), and well as a *Str. uberis* infection sometime in the first three lactations.

We now have fairly good indications of genetic markers for resistance/susceptibility to Str. uberis intramammary infection such that selection of sires for breeding can contribute towards an intrinsically healthy udder, progress towards the 'no mastitis herd'.

BUT, some of our more detailed investigations suggest this is pathogen specific. What happens for Streptococcus uberis *may not apply for other pathogens. However, still a big step forward………*

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Proceedings of the British Mastitis Conference (2024) Sixways, Worcester, p 11 - 20
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PRACTICAL MANAGEMENT OF UDDER HEALTH IN AUTOMATED MILKING SYSTEMS

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SUMMARY

Udder health management in automated milking systems (AMS) has many challenges in common with conventional milking herds (CMS), but also features numerous additional risk factors that are unique to automated systems. Risk factors for intramammary infection (IMI) that are unique to AMS have been described comprehensively in previous BMC proceeding (Greenham, 2020).

Monitoring udder health performance in AMS also has some unique challenges. Detection of clinical mastitis is complicated by different methodologies, high levels of false positive results, and varying strategies of interpreting the data. Sub-clinical infection data also requires careful interpretation, with type of test, sampling regime and frequency of analysis all affecting the results.

To optimise AMS systems, farmers and their advisory teams need to be able to translate the science that describes the vagaries of the system into practical actions for monitoring and managing udder health.

UDDER HEALTH MONITORING IN AUTOMATIC MILKING SYSTEMS

Monitoring mastitis data is an important part of udder health management in any dairy farm. Different patterns of infection are associated with different pathogens and risk factors. Analysing epidemiological data can signpost the key management areas to address for maximum impact on udder health.

Key performance indicators are well established for use in conventional milking herds for both clinical and sub-clinical infection, evolving slowly as performance changes over time (Taylor et al, 2023). Notwithstanding a range of operator variables, conventional herds have relatively consistent approaches to detection methods, test types, milking timings, and sampling frequencies. This allows data from conventional milking systems to inform robust hypotheses about key risk areas, guiding further investigation or actions.

Data from AMS herds often does not fit the established approach for monitoring udder health in conventional dairies. Differences in mastitis detection methods can lead to the same 'true' mastitis rate producing different clinical case data between different AMS farms, as well as compared to conventional herds. Similarly, varying detection and recording protocols for sub-clinical mastitis can present very different pictures of the same somatic cell count scenario.

Clinical mastitis detection

Mastitis detection in AMS varies with different brands of robot. All manufacturers use electrical conductivity, often combined with at least one additional variety of other sensor data. Newer models often have the capacity to customise different combinations of inputs, along with altering thresholds to give bespoke sensitivity and specificity values for the individual farm.

Stated values for mastitis detection sensitivity and specificity are often inaccurate in AMS, due to the absence of a robust 'gold standard' approach to detection in many studies. However, in general terms, if sensitivity is sufficiently high to give rapid detection, specificity will be low, generating a high number of false positive results. This is common to all AMS makes and models (Bausewein et al, 2022).

False positive mastitis results alter perceived mastitis rates, but the change is not consistent across different operators, preventing a standard correction from being applied. Rather than the intuitive increase in mastitis rate, false positives often lead to the farm team ignoring mastitis alerts, only checking cows that they suspect are vulnerable to infection. This can result in under-detection of true positives, reducing mastitis rate below the true value.

A further complication for clinical mastitis detection is the timing of positive test results in relation to clinical signs. It can be common for the sensor technology and algorithm settings to detect milk changes before visible signs are evident to the operator. This may lead to alerts being incorrectly attributed as false positives, with the later clinical presentation being missed.

A beneficial feature of mastitis detection in AMS is its consistency. Test positives may show significant differences to true positive values, but these limitations are largely consistent. This contrasts to conventional milking, where skill level, experience and other social factors may give large differences between test accuracy of different operators.

Sub-clinical mastitis detection

Several layers of complexity exist in monitoring somatic cell count (SCC) in AMS. Various test methods are used, including sending samples to an external laboratory, in-line viscosity testing following addition of a reagent (similar to the

California Milk Test) and on-site fluoroscopy. There is strong correlation between on-site fluoroscopy and conventional laboratory test results, but a lower level of association between reagent testing and the gold standard laboratory test.

Additionally, all testing needs to be interpreted in context of highly variable milking intervals between (and within) cows. Short milking intervals tend to give a higher SCC than milk harvested from the same quarter after a longer interval. To accurately measure a representative SCC value we can take samples from all milkings within a twenty-four hour period, mitigating the different results from different milkings.

In conventional herds, even if there are small differences in inter-milking intervals within a single day, there is usually very little variation in these milking intervals between days. This means that SCC results will be repeatable from one day to another. It also allows for 'factoring' of SCC data from a single milking.

In AMS herds, each cow may have a high degree of variation in milking intervals, both within the same day and between different days. This leads to much greater variation in milk composition between milkings, making factoring much more complicated. In addition, cows in AMS may have a high number of daily milkings, often up to six, introducing practical constraints to full-day sampling protocols. As such, SCC figures tend to be estimated based on test results and milking intervals prior to sampling. This introduces a degree of error to results.

Test frequency also changes how the data is interpreted. Work in conventional herds demonstrates how different targets are appropriate for different sampling intervals (Manning et al, 2022). In AMS herds, individual cow SCC recording may be considerably more frequent, with daily data available from some robot models. This presents new scenarios for data analysis, requiring a modified approach to interpreting performance.

A further consideration is the potential for AMS to perform SCC testing at quarter level, as well as on composite samples from the whole udder. For the same diagnostic threshold of SCC, quarter samples will have a higher sensitivity and lower specificity for detecting IMI (Petzer et al, 2017). This can be accounted for by setting different thresholds for quarter versus composite testing or adjusting targets for each category if using the same detection thresholds.

PRACTICAL APPROACH TO UDDER HEALTH MONITORING IN AMS

The main constraint in assessing clinical mastitis is the variability in calculating and recording mastitis case rates. Options for determining clinical mastitis rate include:

- Simply taking the available figures at face value.
- Using the available figures with different targets to reflect recording error.
    - E.g. If farm protocols increase the risk of under-detection use stricter targets to account for this.
- Attempting to correct the available figures to 'true' mastitis rate to allow conventional targets to be applied.
    - This can be done using known sensitivity and specificity data to calculate true case rate from apparent prevalence. However, in practice this is very complicated due to the variable test frequency. Sensitivity and specificity may vary between the same model of robot due to operators altering detection settings.
- Using alternative data sources to identify true clinical cases.
    - This can be done by using lactation curves to identify yield drops characteristic of clinical mastitis, giving a reliable case rate but of limited current use due to the very large time lag.
    - The data can be made more relevant to the herd's current udder health situation by comparing true case rate to recorded case rate over the same time period. This can then be used to 'calibrate' recent records to give a more accurate, recent case rate.

Clinical mastitis patterns are analysed similarly in AMS to conventional milking herds. Distributions of cases are largely unaffected by the different detection methods described above, so relative proportions of cases across different lactation numbers, days in milk, and groups will be sufficiently accurate to highlight specific risk areas within the herd.

Sub-clinical mastitis records, i.e. somatic cell count data, also need interpreting differently in different testing scenarios.

- Quarter tests should use a higher SCC threshold to indicate infection than udder composite tests to achieve similar sensitivity and specificity.
    - E.g. a SCC threshold of 150,000 cells/ml will have a similar sensitivity and specificity for IMI detection as a threshold of 250,000 cells/ml in a quarter sample (Petzer et al, 2017).

Milking interval prior to samples should be accounted for in estimating daily SCC result.

- Ideally, all milkings within a twenty-four hour period should be included in each individual cow sample.

- If this is not practicable, then SCC results should be adjusted for milking interval(s) prior to sampling, based on previous daily average yields.
- A reliable and convenient method of sampling AMS herds for individual cow SCC is the novel GenoCells technology (NMR, Wolverhampton). This requires genomic testing of the milking herd, but thereafter is an easy and reliable measure of SCC.

Test interval will affect metrics such as ‘New’ and ‘Chronic’ infection rates. Targets for these measures are based on four-weekly test intervals, with greater intervals increasing apparent New rate, whilst reducing the apparent number of Chronic infections (Manning et al, 2022). Conversely, the daily SCC testing does not have well established definitions of New and Chronic infections based on the higher frequency of recording.

- Daily prevalence of sub-clinical infections can be interpreted in the same manner as a monthly recording dataset.
- Dry period performance can also be assessed in the same way as conventional herds, albeit care must be taken with post-calving samples to ensure sufficient time is allowed for the normal peri-partum elevation in SCC to subside.
- For assessment of infection type, various options are available for daily recording herds:
  - Simply use one regular day of data per month as the ‘test day’ to establish New, Chronic, Repeat infections, etc. ignoring the rest of the data for these monitoring purposes.
  - Attribute each cow’s month as ‘infected’ or ‘uninfected’ based on whether a high SCC result has occurred within that window. This leads to increases in infection rates compared to conventional metrics.
  - Classify months as ‘infected’ or ‘uninfected’ based on whether the monthly mean SCC exceeds threshold or not. This tends to underestimate infection rates compared to conventional metrics.
  - Use daily data to establish new measures and performance indicators for new and persistent infections. There is currently no widely adopted format for this type of analysis.

MANAGING ENVIRONMENTAL RISK FACTORS IN AMS

Pre-milking teat hygiene

Teat-cleaning and disinfection is carried out by brushing or dip-cup depending on the model of robot. The major limitation for all methods is the consistency - no increase in cleaning is provided for teats with greater than average soiling. To maximise pre-milking cleaning:

- Keep udder and tail hair short to optimise attachment of cup cleaning.
- Review and refine arm position for brush cleaning:
  - Arm height should ensure the whole teat surface is cleaned, without brushing dirt from the udder skin on to the teat.
  - Forward-rear position should be optimised to cater for the range of frame size within the group.
- Brushes should be replaced in line with manufacturer recommendations.
- Chemical dosatrons should be monitored quarterly to ensure correct concentrations are delivered.

Housing hygiene

To mitigate the limitations of pre-milking teat disinfection it is vital to ensure cows enter the box with clean teats. Cows must be cleaner in AMS, meaning that higher standards of cubicle hygiene and slurry management are required.

- Evaluate cubicle cleanliness and adjust brisket locator and neck rail as necessary to maximise hygiene by optimising lying and standing position.
- Use automated scrapers for slurry management, with frequency set appropriately for passage dimensions and milk yield (in practice it is usually appropriate to run scrapers continuously).
- Review bedding strategy, ensuring that frequency of bedding and cleaning is appropriate for the substrate, with protocols suited to constant cow presence.
- Model ventilation for different weather conditions to inform decisions about bedding management.
- Ensure footbaths are emptied, cleaned, and replenished after one hundred cow passes.

MANAGING CONTAGIOUS RISK FACTORS IN AMS

Surveillance

Due to the high risk of transmission on robot infrastructure, contagious pathogens can go from low to high prevalence very rapidly. Early detection of IMI due to contagious bacteria such as Staphylococcus aureus is vital in maximising efficacy of control measures and reducing losses due to high prevalence of infected quarters.

- Establish routine surveillance for contagious pathogens, including:
  - Monthly monitoring of mastitis and SCC patterns to highlight Staph aureus presence.
  - Bulk tank polymerase chain reaction (PCR) testing for Strep agalactiae and Staph aureus every three months.
  - Quarter sampling of ‘sentinel’ cows (e.g. recent Chronic infections) every six months (or if SCC patterns indicate contagious transmission).

Post-milking teat disinfection

Ensure good coverage of teat skin with an appropriate product for promoting both disinfection and teat skin condition.

- In robots using spray application maximise accuracy of spray jet:
  - Use laser guidance of arm position where available.
  - Optimise height of robot arm for the herd’s udder position.
  - Use sufficient duration/volume of spray to achieve good coverage of teats.
  - Optimise viscosity of product to give sufficient emollient levels whilst still working through spray nozzle.
- In robots using dip application ensure the unit is still attached during dipping:
  - Minimise overmilking to reduce the number of kick-offs.
  - Optimise timings to ensure dipping occurs sufficiently early in relation to cup removal.

Robot hygiene

All surfaces that can contact cows’ teats and udders are potential fomites for infection.

- If contagious pathogens are suspected ensure the milking cups are disinfected between every milking, either with steam, peracetic acid or both.
- All teat-preparation apparatus should be disinfected between cows.
  - The large surface area of brushes makes them impossible to fully eliminate bacteria. If contagious pathogens are present, two sets of brushes should be used on each robot -with sets swapped daily to allow a day of cleaning and soaking in disinfectant before reusing.
- Circulation cleaning must be performed three times per day, with intermediate sanitising rinses useful if contagious pathogens are suspected.

Managing infected cows

Persistently infected cows are a major transmission risk in AMS.

- Use routine SCC recording to identify Chronic infections.
  - Sample for bacteriology to confirm presence of contagious pathogens.
- Unless there is a VERY good reason to retain these cows, cull any animals that are culture positive for contagious pathogens.
  - The more proactive the cull the quicker the problem is controlled and the lower the financial losses.
- If numbers allow segregate 'high transmission risk' cows and run on their own 'dirty' robot.
  - If this is not possible, change the milking permissions for these cows to only allow access to the robot in the hour prior to it being washed. Incorporate these cows into a fetch routine.

MANAGING COW FACTORS FOR IMI RISK IN AMS

Teat Health

Teat end hyperkeratosis is less frequently detected in AMS at problematic levels than in CMS herds. However, monitoring for this pathology should be done at least annually, with vacuum settings, detachment settings and liner choice amended if necessary.

A more common observation is that of teat oedema at higher than target prevalence. If post-milking teat oedema is observed in more than 20% of teats:

- Perform a dynamic machine test to quantify the problem.
- Assess the average and range of teat size within the herd.
- Match liner model to teat size where practical.
    - Liners with vented mouthpiece chambers may be beneficial in herds with a wide range of teat dimensions.

Mobility

Lameness has a much greater impact on AMS herds than CMS herds (Borderas et al., 2008). As such, tolerance levels must be considerably lower.

- Perform regular mobility scoring to identify any lame cows.
    - Aim for less than 1% prevalence and less than 5% incidence.

Trace element status

Low mineral level in robot concentrate feeds can lead to trace element imbalances if not corrected in the mixed ration (Bach et al., 2007). Deficiency in minerals such as Selenium can increase incidence and severity of clinical mastitis (Yang & Li, 2015).

- Regularly monitor maximum and minimum concentrate:mixed ration ratios to allow calculation of mineral provision.

CONCLUSIONS

There are many monitoring and management practices that are common to both AMS and CMS herds. However, in both measuring udder health and minimising udder health risks, there are some processes that are unique to AMS farms. Understanding these AMS requirements allows farmers and their advisors to optimise udder health and benchmark performance against other AMS and CMS herds.

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NOTES

Proceedings of the British Mastitis Conference (2024) Sixways, Worcester, p 21 - 22
The Dairy Group, The University of Nottingham, BCVA & QMMS

USE OF MASTITIS PATTERN ANALYSIS REPORTS TO MONITOR UDDER HEALTH ON UK DAIRY FARMS

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When using the Mastitis Control Plan approach, the first step is to make an accurate diagnosis of the predominant mastitis pattern in a herd, using a combination of somatic cell count data and clinical mastitis records. Mastitis patterns can be classified as either Environmental or Contagious, occurring mainly during the dry period or during lactation. Using this diagnosis, a targeted action plan can be generated for individual farms.

In 2021, an automated Mastitis Pattern Analysis Tool (MPAT) was developed, through the REMEDY project, supported by InnovateUK. Farmers milk recording with QMMS, NMR or CIS can register to receive an MPAT report each time they milk record, highlighting the predominant mastitis pattern on farm. Since 2022, over 400 farms have signed up. This poster describes trends in MPAT reports over the past 2 years.

Pattern analysis reports were generated on the 10th of May 2022 and 2024. The current predominant pattern was identified, using data from the most recent quarter, and any farms with >10% contagious risk were noted. The clinical mastitis case rate was also recorded, to identify farms which were not recording, or may be under-recording (<5 cases per 100 cows per year in the current quarter). Bulk Milk Somatic Cell Count (BMSCC) was calculated based on milk recording data.

In 2022, the average BMSCC was 168,000 cells/ml, which reduced to 165,000 in 2024. Clinical mastitis cases were recorded by 49% of herds in 2022, increasing to 63% in 2024. Of the herds with data, median mastitis rate reduced from 23.2 to 20.7 cases per 100 cows per year.

The most common predominant pattern was Environmental Lactation (EL 59% in 2022 and 55% in 2024), followed by Environmental Dry Period (EDP 25% in 2022 and 30% in 2024), Mixed Environmental (roughly equal risk of EDP and EL: 12% in 2022 and 14% in 2024), Contagious (<1% in 2022 and 2024) and Unclassified (insufficient data: 3% in 2022 and <1% in 2024). Despite a low proportion of farms being classified as 'predominantly contagious', a higher proportion of farms had some evidence of a contagious epidemiology. In 2022, contagious risk was >10% for 3.8% of farms, and this was similar in 2024 (3.6%). Between 2022 and 2024, the mastitis pattern changed in 45% of farms. The most common shift was from EDP to EL – 34% of farms classified as EDP in 2022 had transitioned to EL by 2024. Of the herds with elements of a contagious epidemiology in Spring 2022, 85% did not have evidence of a contagious epidemiology in Spring 2024.

The aims of the MPAT report are to enable farmers to identify problem areas, and make proactive changes on their farm. After two years of the REMEDY project clinical mastitis data is better recorded, and rates are reducing, alongside BMSCC.

Nearly half the patterns changed between 2022 and 2024, highlighting the need for regular review. Furthermore, this study did not take into account seasonality and calving pattern, which can also have an impact on mastitis pattern. The majority of mastitis patterns are 'environmental', but a small percentage of farms are showing evidence of contagious spread. Where there was a risk of contagious mastitis, almost all farms were able to address the problem within two years. The MPAT reports provide consistent and robust analysis of mastitis data, allowing for regular monitoring.

Proceedings of the British Mastitis Conference (2024) Sixways, Worcester, p 23 - 25
The Dairy Group, The University of Nottingham, BCVA & QMMS

EXPLORING UDDER CLEFT DERMATITIS: COW SPECIFIC CONTRIBUTORS REVEALED!

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Udder cleft dermatitis (UCD) is a necrotic, gangrenous skin condition between udder halves or cranial to the front quarters at ventral midline and is associated with foul odour and sloughing skin (2). The aetiology has not been fully defined; some studies have identified *Treponema spp*. in UCD lesions (7), whilst others have not detected its presence (8). A small number of studies in the Netherlands (1 & 5) and Sweden (3,4 & 6) have identified several cow specific contributors including those relating to udder conformation, parity, days in milk, milk production and hock or hoof lesions. There is scarce information regarding the association between lameness, digital dermatitis and UCD. This study aims to investigate whether there is an association of digital dermatitis and UCD in the individual cow, in addition further evidence concerning cow specific risk factors for UCD are presented.

The study was carried out on five predominantly Holstein dairy farms with UCD in Northwest England and North Wales with a milking herd size ranging from 210 to 510 cows. Data was collected in the parlour over three consecutive days. The milking time and the order of the visits differed between farms due to practicalities, but an example programme of data collection is as follows:

- Day one: photographs of the udder and locomotion scoring (AHDB score card) at parlour exit.
- Day two: digital dermatitis (ICAR score) and hock lesions scoring (Cornell University score card).
- Day three: udder cleft dermatitis (3) and cleanliness scoring (AHDB score card).

Individual milk recording data was collected from the most recent milk recording visit before the first data collection day. Photographs from the udder were analysed using ImageJ (open-source, National Institutes of Health, USA) for udder conformation measures following Holstein UK standards. Data was analysed using Stata (v18, Statacorp).

A full data set was available for 1231 animals. Within-farm prevalence of UCD ranged from 24.9% to 33.2% and for digital dermatitis was 27.8% to 39.2%. A multivariable mixed effect model utilising a backward stepwise model building strategy was fitted to investigate the association of digital dermatitis (binary, yes or no) and UCD (binary, yes or no). Potential co-variates considered were parity, days in milk/30, yield at last milk recording, somatic cell count, hock score (binary, yes or no), cleanliness score (flank, leg and udder), locomotion score (binary, yes or no), udder depth, udder height, udder width and udder support. Farm was included as a random effect. Likelihood ratio testing was employed to decided which explanatory variables to include in the final model. Only variables with P<0.2 were included.

Table 1. Model results showing variables associated with presence of UCD.

		Presence of UCD		
Variable		**Odds ratio**	**P>|z|**	**95% Confidence interval**
Presence of digital dermatitis		1.04	0.79	0.80 – 1.38
Parity	1	Ref		
	2	1.48	0.09	0.94 – 2.32
	3	2.10	0.00	1.28 – 3.46
	4	2.41	0.00	1.39 – 4.20
	>=5	3.41	0.00	1.93 – 6.06
DIM 30		1.04	0.02	1.01 – 1.09
Udder cleanliness	0	Ref		
	1	1.35	0.04	1.00 – 1.82
	2	1.51	0.05	0.99 – 2.32
Udder depth (quintiles)	1	Ref		
	2	1.05	0.82	0.71 – 1.54
	3	0.85	0.47	0.55 – 1.32
	4	0.77	0.29	0.47 – 1.26
	5	0.47	0.01	0.26 – 0.85
Udder height (quintiles)	1	Ref		
	2	0.88	0.57	0.57 – 1.36
	3	0.76	0.23	0.49 – 1.18
	4	1.11	0.64	0.72 – 1.71
	5	1.26	0.31	0.81 – 1.96
Farm (variance)		2.65e-34		
ICC		8.04e-35		

Results showed that the odds of a cow having UCD increases with parity, days in milk and udder height. An increase in udder cleanliness and udder depth decreased the odds of a cow having UCD. Digital dermatitis was not associated with UCD.

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Proceedings of the British Mastitis Conference (2024) Sixways, Worcester, p 27 - 28
The Dairy Group, The University of Nottingham, BCVA & QMMS

COMPARISON OF TWO SELECTIVE DRY COW THERAPY PROTOCOLS

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Bacterial culture may give a more accurate measure of the prevalence of intramammary infections (IMI) at dry off than a somatic cell count (SCC)-guided algorithm and potentially reduce the use of antibiotics at drying off. The objective of this study was to compare a novel rapid culture-based protocol where only cows identified as having an IMI due to major pathogens (caused by *Staph aureus, Streptococcus agalactiae, Escherichia coli, Klebsiella* spp., *Mycoplasma* spp., *Strep uberis, or Strep dysgalactiae)* were compared with the current New Zealand industry standard of a SCC and mastitis-based selective dry cow algorithm. The key outcomes were comparing the sensitivity and specificity of the two dry-off protocols at identifying major IMI from all enrolled animals and comparing individual cow SCC at the first herd test after calving from animals enrolled into one of two protocols.

A total of 1541 healthy multiparous pregnant lactating cattle from three 100% spring-calving farms were enrolled in this study. Between 10-14 days prior to dry-off, a composite 4-quarter sample was collected prior to milking. Samples were split at the laboratory into two;, one for conventional culture method and the other for a novel culture method utlilising a custom-made quartered agar plate designed to be rapidly read by a cloud based interpretation, powered by machine learning software. All enrolled animals had a status for mastitis IMI caused by a major pathogen by conventional culture, novel culture protocol (cult-SDCT) and the SCC and mastitis history protocol (alg-SDCT). Alg-SDCT were considered positive for a major pathogen if SCC>150,00 cells/ml at last herd test within 80 days of dry-off or which had an electronic record of clinical mastitis in the current lactation. The sensitivity and specificity of cult-SDCT and alg-SDCT, respectively, were compared against conventional culture results. Animals were then randomized to either cult-SDCT or alg-SDCT group blocked by conventional culture result (major, minor or no growth), where provision of selective DCAT were allocated within protocol group. A total of 776 and 765 cows were enrolled into the cult-SDCT group and alg-SDCT group respectively. Cows allocated to cult-SDCT that had either a major pathogen or a contaminated cult-SDCT result received DCAT. Within the alg-SDCT group, cows defined as positive as above received DCAT.

Across all enrolled animals, the sensitivity (0.80 vs 0.67) and specificity (0.91 vs 0.81) for major IMI prediction was greater for the cult-SDCT method than the alg-SDCT. After accounting for farm, age an dry-off SCC, compared to animals within the cult-SDCT group, animals within the alg-SDCT group had a SCC that was 1.14 times (95% CI 0.99, 1.32) higher at the post-calving herd test.

Compared to a standard algorithm-based protocol using SCC and CM, a novel culture system identified a higher proportion of major pathogens identified by conventional culture, thereby reducing antibiotic use (25 vs 23% of cows treated with DCAT) without increasing post-calving SCC (estimated marginal mean 129000 vs 113000cells, respectively).

Not treating minor pathogens (CNS) with DCAT had no negative consequences in this study. This method of diagnosis and detection of bacteria in the udder could result in a significant reduction in the quantity of antibiotics used globally in the dairy industry

Proceedings of the British Mastitis Conference (2024) Sixways, Worcester, p 29 - 31
The Dairy Group, The University of Nottingham, BCVA & QMMS

TRENDS IN CATTLE INTRAMAMMARY TUBE USAGE OVER RECENT YEARS IN GREAT BRITAIN

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SUMMARY

The sales of intramammary tubes in the GB dairy herd is a useful indicator of dairy cow health and medicine use. Through analysing and combining sales data from a variety of sources, the total intramammary tube usage for the following can be analysed:

- lactating cow antibiotic tubes, primarily used to treat clinical mastitis in dairy cattle,
- dry cow antibiotic tube usage, indicating the adoption of selective dry cow therapy,
- internal teat sealants, a primary component of dry cow mastitis prevention.

INTRAMAMMARY TUBE SALES DATA SOURCES

The data presented is from two sources of wholesaler sales data (GFK and Kynetic[1,2]). Further sales data from direct product sales has also been included when appropriate to ensure a complete data set. The author acknowledges and thanks the pharmaceutical companies that have supported and provided data for this analysis. Data is presented for the current year (year to date, end of Jan 2024) and the 6 years prior to this. Tube sales are presented in millions. Antibiotic data is presented by antibiotic categorisation based on the EMA guidelines from January 2020[3].

LACTATING COW INTRAMAMMARY ANTIBIOTICS[1]

Figure 1 Lactating cow intramammary sales

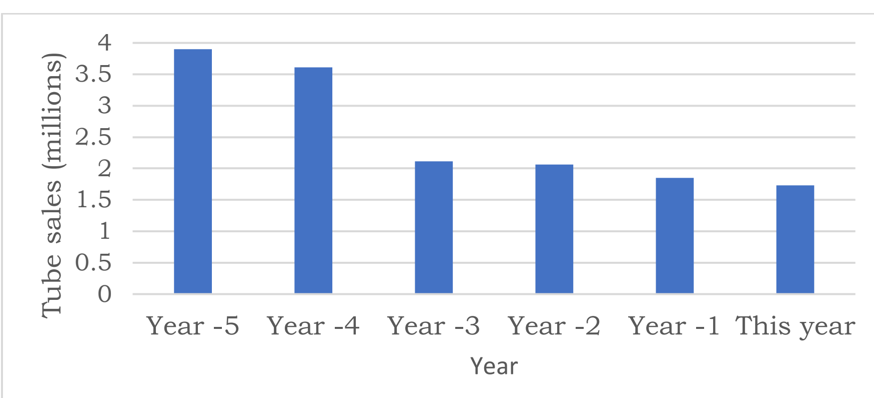
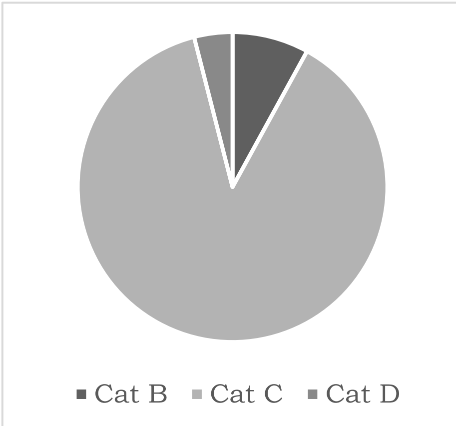
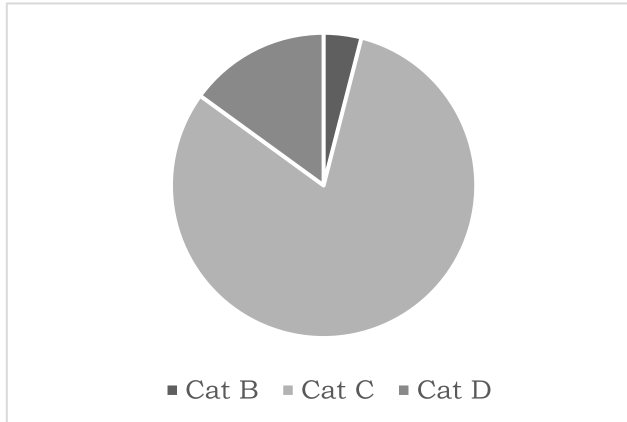


Figure 2 Lactating cow intramammary sales by EMA category, five years ago (left) and current year (right)

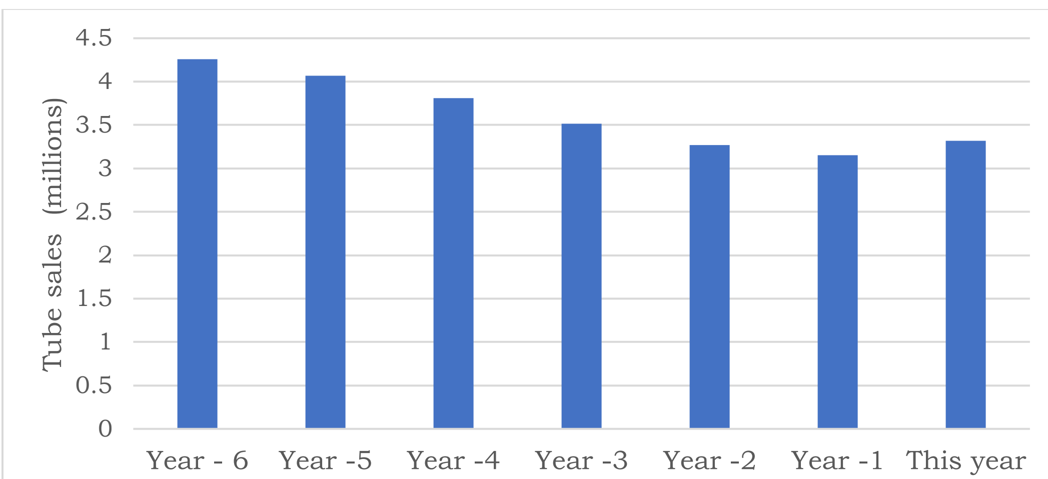




Lactating cow intramammary use has reduced significantly. Current sales figures indicate usage to treat 25 cases/100cows[4]. Category B usage has halved but is still a numerically high figure (approx. 60,000 tubes).

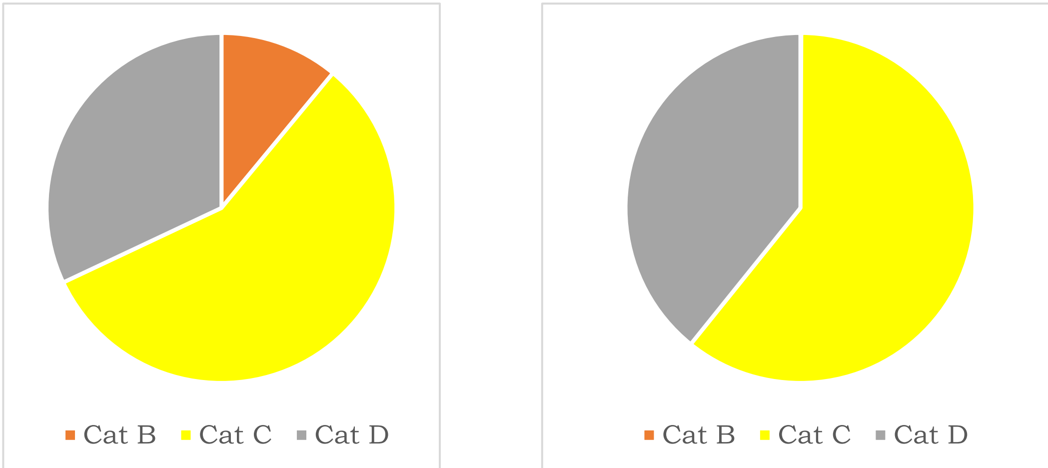
DRY COW INTRAMAMMARY ANTIBIOTICS

Figure 3 Dry cow intramammary sales



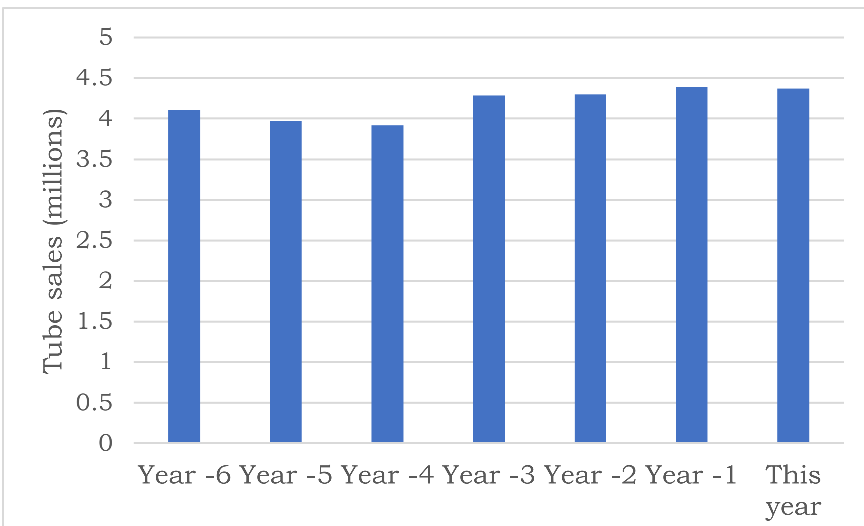
Dry cow intramammary use has reduced and remains relatively stable. Current sales figures indicates that approximately 44% of the national herd receive antibiotic dry cow therapy[5].

Figure 4 Dry cow intramammary sales by EMA category, five years ago (left) and current year (right)



INTERNAL TEAT SEALANTS

Figure 5 Internal teat sealant sales



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4. Cow numbers – AHDB, 3 tubes per treatment course – AHDB Medicines hub figure/VARSS figure
5. Cow numbers – AHDB, calving interval – NMR KPI data

NOTES

Proceedings of the British Mastitis Conference (2024) Sixways, Worcester, p 33 - 40
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REDUCING SOMATIC CELL COUNT IN A SPRING CALVING HERD

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SUMMARY

How and why, we reduced our average annual SCC in our spring block calving herd from 187,000 to 89,000. I will look at the issues we found from a practical point and the data we used to pinpoint the bottle necks and problems within our system, together with the hands-on approach by the whole team to solve these. I will touch on the financial implications but also the time lost and negative impact on team morale when dealing with high SCC.

INTRODUCTION

The farm comprises 700 acres with 520 spring calving cows in a partnership with Robert Craig in the Eden Valley, Cumbria. My farming career started young with non-farming parents but with two uncles farming, I have never wanted to do anything else and been lucky enough to never have to. Spending any time possible on the farms or staring out the window at school at what was happening outside was the natural progression for me. After school I attended the now defunct Newton Rigg college and then went onto higher education at Myerscough college, completing a foundation degree in agriculture. This was done part time while working on various dairy, sheep and arable farms. Finishing college and working I felt I was stuck in a bit of a rut. I then decided to head to New Zealand, with my future wife Lucy, for the next 18 months. It was a fantastic experience for me working in large block calving herds getting a chance to hone skills on the vast numbers of cows, for example drying cows off etc by the hundred you learnt the value of standard operating procedures and time management, and for Lucy (a self-confessed townie at the time) the experience would be very formative.

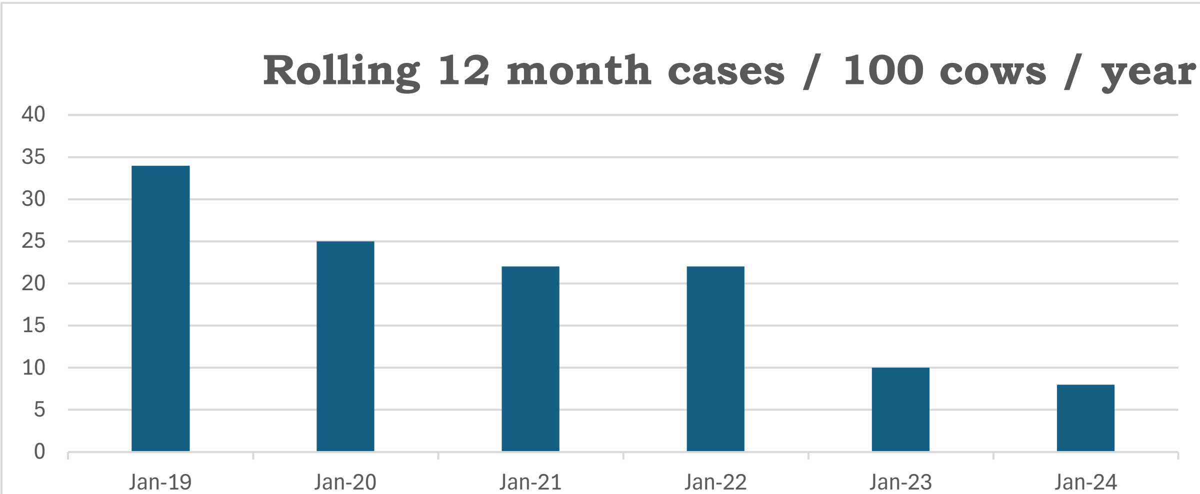
Returning home and working for family and with other well respected pedigree Holstein herds an opportunity became available part-time at Dolphenby farm about 20mins from where I grew up with a spring block calving grazing herd. I was keen to see this replicated in the UK and I was working with 2 award winning farmers and seemed an opportunity not to be missed. A 6-month stint self-employed turned into a full-time job ahead of a busy calving time in spring 2016. That autumn the current manager was moving on and a further opportunity became available for me to step into that role with the guidance of Robert and Steve. Fast forward 6/7 years now with a wife and child I am now the tenant here at Dolphenby alongside Robert on a 15-year FBT.

Dolphenby Farm, where I live with Lucy and our daughter Neave, is circa 700 acres of mainly light sandy ground about 5 miles east of Penrith in the Eden valley. As stated earlier we are now 1 year into a 15 year FBT, calving over 500 cows starting early February through until the end of April. Dolphenby is pretty much all in a ring fence and is very well set up for block calving and grazing cows, with just over 400 cubicles. These are bedded on a mixture of materials plus straw yards for a further 80ish cows. We are generally stocked at around 2.5 cows/ha across the farm. We are milking, I would say, more of an Irish cross bred black and white herd with cows weighing on average 525-550 kg More recently we are using Irish genetics built from a kiwi base with cows averaging 6100 litres, 554kgs milk solids and feeding around 1.25 tons of concentrate. We are milking in a 12-year-old 40/80 Waikato parlour with no ACRs or milk meters that we find very suitable for the job. Two people milk with a 3rd getting cows. We employ a simple routine through the grazing months with no teat prep, with afternoon milkings mid-summer all done in just over 2 hours. We have a great team of people involved with three full time members of staff with a handful of part timers - all have helped pull in the same direction whilst we've targeted reducing SCC.

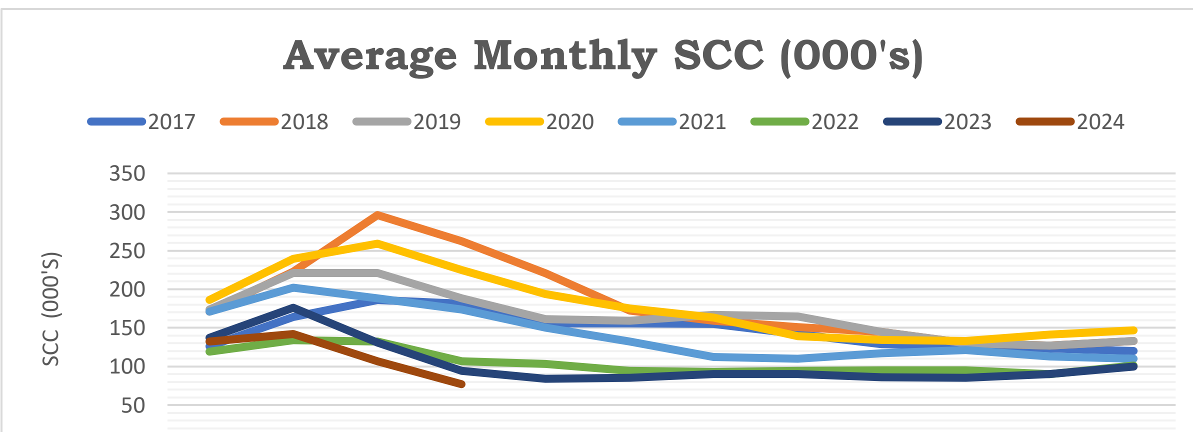
CHANGE

As the herd matured from all heifers brought in from 7 different farms, when originally established in 2012/2013 there was an expected rise in average SCC that went along with this. At this point the peaks and troughs could be fairly easily managed but in spring 2018 - with some poor dry off decisions, some adverse weather in the form of the "beast from the east" and a peak calving work load the SCC spiked. We had a good 6 week in calf rate of 80%+ and were calving a few more cows (around 560) which put buildings under strain if we were unable to graze. SCC peaked at nearly 450,000 in early March averaging 300,000 for the month. At this point we were missing out on bonuses and incurring penalties from our milk buyer that I was not willing to accept. As any farmers in the room know we cannot really set milk price but there are things we can do on farm to ensure we are getting the best price possible. It was very frustrating to try and control and find the cause, so we sought the help of Ian Ohnstad. Cows were heading toward peak milk production and initially it was a case of firefighting as Ian spent some time analysing data and trying to find the root cause of our issues. You can see from the table and graph what we've been able to achieve with first clinical cases of mastitis and the overall reduction in SCC.

Table 1



Graph 1



	January	February	March	April	May	June	July	August	September	October	November	December
2017	126	164	186	181	156	156	155	142	129	126	123	120
2018	171	223	296	262	221	172	159	151	145	130	127	133
2019	174	221	221	188	161	159	167	165	145	130	127	133
2020	186	239	259	225	194	175	163	139	134	133	141	147
2021	171	202	188	174	150	132	112	110	117	121	113	110
2022	119	134	132	107	103	94	93	94	95	95	90	101
2023	137	176	131	94	84	85	90	90	86	85	90	100
2024	132	142	107	77								

MONTHS

TEAT SEALING HEIFERS

One of the main things that analysing the data flagged up was the number of clinical cases of mastitis and high SCC test in first calvers at calving and in the 30-day period post calving. At this point and, still to a degree now, in-calf heifers are out-wintered on a varying area of different grass and bales which can work well on our light ground but in periods of prolonged wet weather or, in the later part of the winter when these animals have been over the same area 2 or 3 times and are starting to bag up, we felt this was opening them up to an increased chance of infection.

So we looked at our options as building were busting at the seams. We didn't want to ship them off to housing elsewhere and putting a building up at that stage was out of the question. So we looked at some external sealing products but felt that doing the job once properly was the best route. After a couple of years of debate and the data suggesting the same issue but still a little sceptical, we decided to do a trial and teat seal a random 74 of the 128 in-calf heifers in December 2020. (I'll have to apologise I didn't think I would end up doing a presentation on this so don't have a huge amount of data) as SCC increased again to 551,000 on the 11th Feb 2021 with the 62 heifers and 34 cows calved in to that point, I decided to California milk test all the fresh calved animals and found 5 heifers to be extremely high on the CMT, none of which had received sealant. These were all tested and kept out of the bulk tank. The SCC then reduced to 178,000 and averaging 202,000 for the month in the end.

This was more than enough to give me the confidence to teat seal all the heifers, around 130, the following December. As with any dry cow therapy cleanliness is paramount and I feel even more so when sealing heifers. We initially did this through a foot trimmer's raised crush to avoid injury to man and beast and to allow the time to be spent under the animal in order to do the job correctly. This was not a job I was involved during our time in NZ but I believe is very commonplace. As with anything like this you learn as you go, and I found it was best not to try and do too many in a day. As I have mentioned, we have a very capable team at Dolphenby but this is a job I prefer to do myself, and if there's an issue it's my fault. I've found it is best to walk away and leave a heifer that has a certain degree of warts or a certain temperament (something I'll discuss later). We have since performed the task through the parlour and to my surprise has been quite quick and calm. This is by no means, whatsoever, a job I look forward to but I do feel has been a huge factor in reducing our SCC and clinical cases of mastitis. Looking at the table, particularly cases of mastitis in heifers, we can see the significant reduction especially when we have treated the whole group for the following year.

Table 2

Calving Season	Total mastitis cases < 30DIM	% cases in heifers
2019	37	43
2020	30	40
2021	32	81
2022	22	9
2023	7	0

WARTS

Dolphenby is set in a very beautiful area with lots of woodland, the rivers Eamont and Eden run along the boundary. Some of the areas around these woods and water are a little more marginal and can't be cut but lend themselves quite well to grazing youngstock, but with this comes flies. After some research and speaking with vets it looked quite likely that the wart virus was being passed around youngstock. At this stage we were having to cull 2 or 3 fresh calved heifers each spring that were un-milkable with the number of warts on teats as well as others milking on ¾ after cases of summer mastitis. We were already treating both groups of youngstock with some fly treatment 3 or 4 times over the course of the summer but this was stepped up to once a month from early May to October along with a once a fortnight dose of Stockholm tar / again no-one's favourite job but seem to deliver results in the form of better teat condition. This also gets you up close and hands on when checking for summer mastitis and more recently the benefits have been only culling 1 heifer in the last 3 years for warts. This is a time-consuming job on what seems to be an increasingly busy farm and more recently we have come into some issues with very loose tar that doesn't seem to stay on the teats for very long. This is a job we are evaluating whether we continue to do, but I do feel as there has been some really positive steps made. However, the products have to be up to scratch to make it worth my time and worth the no doubt stress on the animal.

TEAT CONDITION

Another point identified as a possible point of infection was teat condition. Milking in a fairly long parlour with no ACRs will at some point lead to instances of over milking. Normally 2 / 2.5 people are in the parlour per milking but whilst cows are housed this increases to three as we are wiping teats. In addition, we are not using all 40 units and knocking them back to 35 or even 30 units to allow time for the extra preparation. Along with the parlour running at a low vacuum 42kpa seemed fine, but having another set of eyes that spends a lot of time looking at teats (I'm sure there's a joke in there somewhere) made us question the relatively low specification iodine-based teat spray we were using and we moved to lactic acid, chlorhexidine and peppermint oil based teat spray. We have seen a huge improvement in teat condition for little or no extra cost, which is something we are now challenging again. We are looking to see if we can improve teat condition further by using a higher spec teat spray for February/March when the majority of the herd calve. The cows have had 60+ days with no teat spray, are lying on beds dusted in lime and then they go outside in cold wet weather which will still leave teats chapped and dry for a while but this improvement in skin condition even with no real stimulation time in the parlour can be seen in Graph 2 we now have very minimal level of hyperkeratosis.

MONTHLY MILK RECORDING

One of the first changes we made that spring was to move from quarterly milk recording to monthly. Not all members of the team are overly excited by this, but the information gathered is invaluable. Some of the poor management decisions mentioned earlier included using selective dry cow therapy (which I will go into more detail later) in January / February using data gathered from a milk recording in November with a six week once a day period in between / this was a big lesson learnt.

ZERO TOLERENCE ON STAPH AUREUS

The monthly milk recordings allowed us to build a much better picture of the chronic SCC cows in the herd some of which were easy decisions to be culled out of the herd but others not so much. At least twice a year I will sample some, if not all, the chronic cows in the herd and send off for analysis. These results can lead to treatment of specific quarters, or we have some cows in later lactation we have just stopped milking on one quarter if it's a persistent problem to let her dry up and hope for better results next lactation. Anything that comes back with a *Staph aureus* is then moved into the TLC group we run and milked last, so hopefully cutting the spread of the infection and culled out the herd at dry off or just before.

C.M.T

Another change in management practice now is that every fresh calved cow and heifer's milk is tested before she enters the main herd. In a block calving system this can cause a bottle neck in the building but would be made much worse with a blip in mastitis cases. If the animal doesn't pass, she'll be held in that group with udder mint applied until she does clear up or will be treated if need be. This has been a fantastic way to control SCC and becomes much easier as SCC reduces but can be very time consuming in an already busy point of the day.

SELECTIVE DRY COW THERAPY/ DRYING COWS OFF

Pressure from outside to reduce antibiotics at drying off and with us doing so "blind" in hindsight led us to several years of blanket antibiotic dry off treatments to reset after feeling we had had our fingers burnt. I had always felt we had very good drying off protocols< it wasn't a job that was ever rushed. It is always done after washing out and after everyone has had a chance to sit down and grab breakfast. Depending on how many people are around that day we don't do more than 60 in a day. I find this is enough for anyone. Cows' teats are meticulously cleaned, firstly with teat spray and a dry wipe as a standard routine milking. We then milk them again as it can often be late morning by the time we get to do this, we then use cotton pads soaked in surgical spirit to vigorously scrub the teat and whilst holding the teat with the other hand. It is important to note this is to disinfect, the teat should be completely clean to the eye at this point surgical spirit will not disinfect the teat if there is visible dirt there. Teats are cleaned front to back and then tubed back to front, hands washed and disinfected between each cow and generally I will mark cows for sealant or antibiotics as they come in the parlour. As well as marking the cows done and helping with more difficult animals, cows are left to stand and eat on a clean yard for 30 mins before being let back onto cubicles.

We have felt comfortable enough to start being selective with dry cow therapy, again using quite strict parameters. Any animal that has had a test over 100,000 in that lactation or a case of mastitis will receive antibiotics which I know seems strict but with SCC reducing we are able to still do a decent proportion of the herd. In 2022 /2023 17% of the herd were dried off with sealant only. In 2023/2024 32% of the herd were dried of with sealant only with SCC reducing further and confidence in the data I feel we will move the parameters to 150,000 for this coming drying off period which should take us to over 50% sealant only. I should also mention we don't fully dry off and milk cows through on a once-a-day basis which does cause a spike in SCC. What I look at that point is the increase in SCC for the individual cow, e.g., a cow with a running SCC of 25,000 and going to once per day milking this lifts to 95,000 I will treat with antibiotics although a cow with a running SCC of 95,000 that lifts to 110,000 I would consider not treating as the rise has not been as great as the previous example.

CUBICLE CARE/COW CLEANLINESS

I have now invested in a tractor mounted cubicle bedding machine which has allowed us to make use of bulk products. It has turned a very mundane dusty twice a day job in to a three times a week task sat on a tractor seat! We now use vast amounts more product and has increased our costs in this area considerably but is much easier and cubicles and cows in turn are much cleaner. I have used several different paper and sawdust products and not found something I'm 100% happy with. What I have found is you generally get what you pay for. We've kept the lime use consistent when trialling different materials using hydrated lime each morning on milking cow and dry cow beds and have seen this seems to keep bugs at bay.

We now much more routinely clip cows tails up to 4 times a year and I've bought an udder singeing tool that, when used carefully and correctly, makes for very easy pre/milking preparation in the winter months.

CONCLUSION

As a business we send annually around 3 million litres of milk, and our milk contract has a 0.5ppl bonus if SCC is kept under the 200,000 threshold. So, this alone is worth £15,000 to our business. According to AHDB a 'case of mastitis can cost between £250-£300 due to vet costs, reduction in yields, and loss of milk'. With the reduction in cases of mastitis from 37/100 cows to 7 per hundred cows based on 500 cows this is a further £37.5 k along with now reducing the amount of dry cow antibiotics purchased and time spent dealing with these issues, it becomes a sizeable sum.

But what we have found as one of the biggest wins in reducing SCC is the time that has been freed up in not now constantly looking for that next high SCC or mastitis case. We now no longer routinely dip units post/milking or strip the herd, having everyone on board with a common goal and achieving this has given the staff morale a huge boost.

Goals for the future are to maintain our current SCC and cases of mastitis treated levels, whilst reducing the amount of antibiotics used at drying off and to improve teat condition through the early spring months.

NOTES

NOTES

Proceedings of the British Mastitis Conference (2024) Sixways, Worcester, p 41 - 48
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MEETING THE CHALLENGES OF CHLORINE-FREE CLEANING OF MILKING EQUIPMENT

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INTRODUCTION

Chlorate has emerged as a residue of concern in recent years due to its capacity to inhibit iodine metabolism in the thyroid gland. This inhibition is of particular importance to infants and young children whose thyroid gland is inherently underdeveloped. Therefore, chlorate is of particular concern in infant milk formula (IMF) manufacture. Chlorate is a product of chlorine degradation which occurs over time in sodium hypochlorite and chlorine dioxide, depending on storage conditions. These products are commonly used in the cleaning and disinfection of both milking equipment and food processing plants. They may also be used for water disinfection, with this water being subsequently utilised by some dairy farms and milk processing sites. A further residue linked to chlorine use is Trichlormethane (TCM), which is relevant to the production of lactic butter in the Republic of Ireland (ROI). The importance of both IMF and lactic butter to export markets and the importance of minimising the risks that chlorine derived residues pose has resulted in the use of chlorine for cleaning and disinfection purposes being prohibited on dairy farms in Ireland since January 1st 2021. This paper details how to effectively clean milking equipment using ‘chlorine-free’ cleaning protocols.

Chlorine based cleaning of milking equipment

A milking machine wash routine traditionally used in Ireland had three stages; a post-milking rinse using clean cold water at a target volume of 14 litres/ milking unit, a main wash cycle using a detergent/steriliser product at a target volume of 9 litres/ milking unit and a final post detergent/steriliser rinse with cold water at a target volume of 14 litres/ milking unit. An additional sanitizing rinse using sodium hypochlorite was used in some instances, particularly where variability in water quality was evident. An acid descale wash was used once weekly to counteract mineral deposits on plant surfaces; this was followed by a detergent steriliser wash to remove any lingering soils in the plant. Cleaning of bulk milk tanks followed a similar process, whereby the bulk tank received an initial rinse with cold water followed by a main wash with a detergent/steriliser using a volume of water equivalent to 1% of the tanks total capacity. This in turn was followed by a final cold-water rinse to remove any detergent residues. Again, an acid descale wash was used (in place of the detergent/steriliser cycle) after every third milk collection.

Chlorine-free cleaning of milking equipment

In response to the removal of chlorine-based chemicals, new chlorine-free cleaning products and wash protocols were developed. These were trialled initially on research farms (Gleeson et al., 2013) and subsequently on commercial dairy farms (Gleeson et al., 2022). Five wash protocols were developed for use with milking machines and three protocols were developed for bulk milk tanks (https://www.teagasc.ie/media/website/animals/dairy/research-farms/Chlorine-free-wash-routines_2020.pdf).

These protocols involve a combination of alkali detergent washes (sodium hydroxide), acid descales (phosphoric/ nitric acid) and in some instances, the use of a sanitizer (peracetic acid). As sodium hydroxide is manufactured in in conjunction with chlorine during the 'chlor-alkali' process, sodium hydroxide is 'chlorine–free' but it is not 'chlorate-free'. It can contain residual amounts of chlorate, but at much lower levels than those found in detergent steriliser products. Peracetic acid is effective against a broad range of bacteria, spores, moulds, yeasts and viruses making it a credible alternative to sodium hypochlorite. The decision as to which protocol is best suited for an individual farm depends on the number of milking units, the amount of axillary equipment, e.g., milk meters, automatic take-off etc., availability of adequate hot water and water hardness levels. For example, larger plants (16+ units) with additional equipment, such as dump lines and milk meters require the main wash cycle to be conducted with hot water twice daily, with at least two of those hot detergent washes per week being replaced by acid descale washes. In the absence of chlorine, an increased number of descale acid washes are required to ensure the effective removal of mineral deposits in milk pipelines and claw-piece bowls. Such 'build-up' can harbour thermoduric bacteria, thereby, compromising milk quality. On farms where the water used for cleaning is considered hard (measure of calcium carbonate on a four point scale; soft (0-60 mg/L), moderately hard (61-120 mg/L), hard (120-180 mg/L) and very hard (>180 mg/L), choosing a protocol with an increased number of acid descale washes per week (n=7) is recommended in conjunction with the use of a water softener. Hard water can inhibit detergent activity by sequestering the detergent,thereby leaving it unavailable to clean.

A protocol using sodium hydroxide detergent in powder form is recommended for small plants (<16 units with no axillary equipment) where hot water availability is an issue and manual cleaning (no automatic washer in place; detergent solution added manually) is carried out. However, this protocol must include a minimum of 3 hot wash cycles per week. This reduced hot wash frequency is facilitated by the fact that powder detergents typically contain 60 - 80% sodium hydroxide, while liquid detergents typically contain 12 -29%. In the ROI, the chemical composition of detergent products is analysed at an independent laboratory to establish the levels of sodium hydroxide and other product ingredients (sodium carbonate, buffers and surfactants). To achieve target alkaline working solutions (using sodium hydroxide) in hot (1200ppm) and cold (2000ppm) water, a product concentration of approximately 24% is recommended (Table 1). If products have lower product concentrations, then higher usage rates may be necessary. One of the most popular protocols adopted on farms with automatic cleaning systems involves a liquid sodium hydroxide detergent used in the main wash cycle on 11 occasions per week, 4 of which must be with hot water, together with 3 acid descale washes, all of which would be followed by an additional final rinse with peracetic acid. When used with cold water, a 1% concentration of liquid sodium hydroxide detergent is required whereas, a 0.5% concentration is sufficient when used with hot water. Alternatively, a 1% solution is generally applied for all acid descale washes. Peracetic acid is the only alternative to sodium hypochlorite disinfectant available to farmers and for CIP cleaning at milk processing sites. The recommended usage rate for peracetic acid is 0.13% (60mls/45L). It is degradable and further rinsing is not required if adequate time elapses between its use in the final rinse and the next milking event.

Table 1. Impact of the concentration of a sodium hydroxide solution and its usage rate on the final working solution (ppm)

Usage rate	**18%**	**20%**	**24%**	**28%**
0.5% (225ml/45L	900	1000	1200	1400
0.6% (270ml/45L)	1080	1200	1440	1680
0.7% (315ml/45L)	1260	1400	1680	1960
0.8% (360ml/45L)	1440	1600	1920	2240
1% (450ml/45L)	1800	2000	2400	2800

Farm management factors that can affect successful chlorine-free cleaning

The success of chlorine-free methods of cleaning milking equipment is dependent on increased attention to the fundamentals of cleaning. Research trials and observations on commercial farms have shown that milk residue can build up on the internal surfaces of some milking plants after a number of months, when chlorine-free cleaning products are used incorrectly. Observation of a greasy or yellow residue inside the claw-piece is evidence of fat and protein deposits. A hard clear or brown build up indicates mineral scale build-up. Identifying the cause of a build-up of milk residue requires a detailed examination of the wash routine on the farm. The residue build-up is generally associated with insufficient hot washes, low water temperature, low detergent levels (particularly when cold water is used for the detergent wash) and inadequate acid descale washes applied per week. Adequate volumes of hot water at the correct temperature is critical for good cleaning.

Importance of calibrating chemical dosing equipment

It is necessary to re-calibrate automatic detergent dosing systems for both the milking machine and the bulk milk tank when switching to chlorine-free cleaning products. This is necessary to ensure that the correct volume of detergent/acid is used. Viscosity and therefore uptake rates can differ between the previously used chlorine products (sodium hydroxide content of ~15%) and the new chlorine-free products due to the higher caustic content of up to 30%.

Ensuring that adequate volumes of wash solution and rinse water levels are used

To establish the exact volume of chlorine–free detergent to use for a specific milking plant, it is necessary to know the exact quantity of water being used in the wash trough. This is achieved by measuring the dimensions of the water trough; length (m) x width (m) x height (m) to water level mark = cubic meters, divided by 1000= litres. A sufficient volume of the detergent wash solution (9 litres/milking unit) is necessary to ensure that all surfaces will be in contact with the detergent solution. It is also important that the turbulence system (air injection) for large plants is functioning correctly (air injection every 30 - 40 seconds) and that the vacuum level is maintained during the wash cycle. Furthermore, a similar calculation should be carried out to establish that adequate rinse water levels are used (14 litres/unit). Inadequate rinsing (post milking rinse) will result in milk residue entering the detergent wash solution making it less effective or detergent residue ending up in the bulk milk tank (post detergent rinse). A warm post milking rinse is preferable to a cold water rinse, this helps to maintain plant internal surface temperature and helps in the removal of fat deposits.

Impact of chlorine-free cleaning strategies on the microbiological quality of milk

When implemented properly, chlorine-free cleaning of milking equipment does not lead to poorer milk quality from a microbiological perspective (Gleeson et al., 2022). In a study undertaken on commercial dairy farms where farmers were advised on how to conduct effective chlorine-free cleaning, no negative impact was observed in milk quality (Table 2). Furthermore, chlorine-free cleaning has also been deemed effective in milk processing environments based on bacterial counts being maintained within relevant limits (Twomey et al., 2023). When raw milk from commercial dairy farms in the ROI was examined from a microbiological diversity perspective, little to no differences in microbiological composition were found in milks produced on farms using chlorine or chlorine-free detergents (Yap et al., 2021). In a separate study (one milk processor) total bacteria and thermoduric bacteria counts were monitored for a period before (2018, 2019 and 2000) and after (2021, 2022 and 2023) the mandatory removal of chlorine from milking plant cleaning on-farm. No differences in total bacteria count (TBC) were observed in that study; average TBC across both time periods was $21x10^3$/ml. However, thermoduric bacteria levels were increased in milks post chlorine removal; 7% of farms had an average milk thermoduric count >1000cfu/mL in the 3-year period prior to chlorine removal and this increased to 14% after the introduction of chlorine-free cleaning products. Thus, increased focus on aspects of cow cleanliness and milking equipment cleaning is required at farm advisory level to maintain low thermoduric levels going forward.

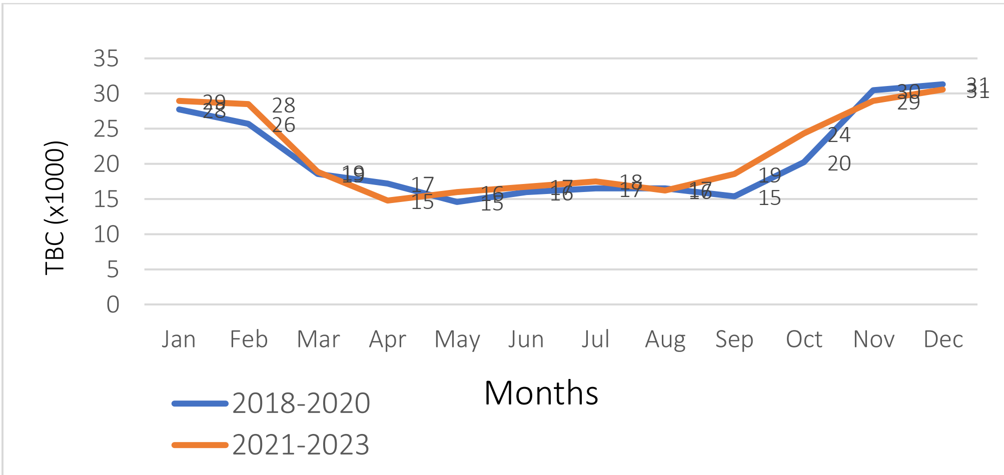
Table 2. Median* bacterial levels (cfu/mL) in bulk tank milk samples from farms using chlorine based cleaning products (CB), chlorine-free cleaning products (CF) or chlorine-free products used in the bulk tank only (BTCF).

	Treatments			**Significance**
	CB	**CF**	**BTCF**	**Treatment**
Total Bacterial counts	12,454[a] (8,307-18,672)	3,168[b] (2,406-4,172)	6,091[ab] (3,874-9,580)	<0.001
Psychrotrophic bacteria	2,442[a] (1,560-3,822)	838[b] (620-1,134)	1,291[ab] (783-2,131)	<0.001
Thermophilic bacteria	50[a] (9-292)	1[b] (0.4-3.9)	15[ab] (2-107)	<0.001
Laboratory Pasteurisation Count	92 (29-290)	43 (20-92)	81 (23-292)	NS
Faecal Streptococci	68 (24-196)	147 (72-300)	48 (15-157)	NS
Bacillus Cereus	0.022[a] (0-0.01)	0.001[b] (0.02-0.19)	0.002[b] (0-0.03)	0.07

*Median levels represent back transformed log figures

Figures in parenthesis represent the range in bacterial levels.

Figure 1. Average TBC levels before chlorine removal (averaged over 3 years; 2018, 2019, 2020) and after chlorine removal (averaged over 3 years; 2021, 2022, 2023)



Impact of chlorine-free cleaning on residue levels in bulk milk

To establish the impact of chlorine free cleaning protocols on the residue levels in bulk tank milk, bulk milk samples were collected from 6 milk processors and were analysed for chlorate and TCM residues across the main milk production seasons (March – November) of 2020 (n=1,741) and 2021 (n=1,884); 2020 and 2021 represented the periods before and after chlorine-free cleaning was introduced, respectively. In 2020, 15% of the samples analysed had detectable levels of chlorate, but this reduced to 8% in 2021. The levels of TCM detected in milk in 2020 (0.00005 – 0.081 mg/kg) were also reduced in 2021 (0.00000 – 0.023 mg/kg). Thus the adoption of chlorine-free cleaning on dairy farms in the ROI has led to a reduction in both the levels (mg/kg) and occurrence of both chlorate and TCM residues in bulk tank milk. However, remaining residues in bulk milk may be due to other factors such as the use of chlorinated water for cleaning milking equipment and teat disinfectants, which contain chlorine dioxide.

Importance of water drainage from the milking plant to avoid residues

Many farmers use public water supplies for cleaning milking equipment, and these supplies are normally disinfected using sodium hypochlorite. Therefore, this water has the potential to cause chlorate contamination of milk. Chlorate residue was detected in milk when water (containing chlorate) and milk came in direct contact within the milking plant (Twomey et al 2023). This was demonstrated by sampling milk from a number of rows of cows milked through a milking plant with the first rows of cows milked being the only ones that displayed detectable levels of chlorate. Additionally, the freezing point of this milk was higher than would be expected, indicating the presence of water in the milk. The main mechanisms by which this contact between water and milk occurs are (a) water remaining in the milking system after rinsing (following washing) due to poor drainage of the plant, and (b) allowing the contents of the milk inlet pipe to enter the bulk tank before the water has been eliminated from the system prior to milking. Direct contact between water and milk can be prevented by (i) installing sufficient drainage valves at the appropriate points along the milking system. The bulk milk tank itself is also a potential source of contamination and should be inspected post-washing to ensure that water is not being retained. Chlorinated water should not cause chlorate contamination in milk unless the milk is exposed to rinse water. Poor drainage can also influence the performance of a hot detergent wash cycle by reducing the temperature of the wash cycle, which in turn can influence plant cleanliness and therefore milk microbiological quality.

Teat disinfectants and chlorate levels in milk

Chlorine dioxide may be used as an ingredient for teat disinfection. It has been demonstrated that milk spiked with a teat disinfectant containing sodium chlorite or chlorine dioxide results in chlorate levels being detected in that milk. To test the impact of a range of teat disinfectant ingredients on chlorate levels in milk, ten disinfectant products were selected based on their active ingredients. One millilitre of each disinfectant product was added to 30 mls of milk, with each sample repeated in duplicate. The active ingredients included Chlorine Dioxide, Iodine, Lactic acid, Chlorhexidine and Sodium chlorite. One milk sample did not have disinfectant added and represented a control sample; chlorate was not detected in this control milk sample. However, all disinfectant products based on chlorine dioxide, chloride or chlorite resulted in relatively high chlorate levels in milk (>0.40 mg/kg). It is thought that chlorates would have been detected even if considerably lower levels of disinfectant were added to the milk. Iodine, Lactic acid, chlorhexidine, chlorhexidine combined with lactic acid, and lactic acid combined with salicylic acid did not result in detectable levels of chlorate. It is recommended that chlorine based teat disinfectant products should only be used as a post-milking disinfectant if adequate teat preparation is undertaken prior to next milking, in order to minimise the risk of chlorate contamination of milk.

CONCLUSIONS

Attention to wash protocols, detergent usage rates, water temperature and frequency of acid descale washes are all critically important (in the absence of chlorine) to minimize milk residue building up on plant surfaces and consequently minimise thermoduric counts in bulk milk. The adoption of chlorine-free cleaning protocols on dairy farms in the ROI has resulted in a significant reduction in both the levels and occurrence of both chlorate and TCM residues in bulk tank milk. Some remaining residues detected on a minimal number of farm milks may be due to intermittent use of chlorine, misuse of chlorinated water and some teat disinfectant products.

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The Dairy Group, The University of Nottingham, BCVA & QMMS

IMPLEMENTATION OF THE AHDB DAIRY MASTITIS CONTROL PLAN: REDUCING ENVIRONMENTAL INFECTIONS AND CLINICAL MASTITIS INCIDENCE RATE

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SUMMARY

The AHDB Dairy Mastitis Control Plan was implemented in the autumn of 2020 for an all year round calving dairy herd after a request for a second opinion for increased clinical mastitis incidence rate. Following analysis of individual cow somatic cell count data and clinical mastitis event data from the milk recording and on-farm database, the herd mastitis infection ‘pattern’ was judged to be predominantly one of environmental infections of apparent lactating period origin, with seasonal infection patterns associated with summer and Gram-negative infections confirmed on bacteriology.

A focus on lactating cow management was prioritised through 2021 and 2022, which included improvement of building ventilation, increased availability of loafing space, cubicle bed management and pre-milking teat disinfection routine. Whilst the *herd average* somatic cell count (SCC) remained similar (181,000 cells/ml for the 12 months ending autumn 2020 and 172,000 cells/ml for the 12 months ending autumn 2023), there has been a dramatic reduction in the incidence rate of clinical mastitis events. Between the end of 2019 and the end of 2023, the incidence rate of clinical mastitis decreased from 60 cases per 100 cows/year for the 12 months ending December 2019 (135 clinical mastitis events reported), to 25 cases per 100 cows/year for the 12 months ending December 2023 (57 clinical mastitis events reported), with no change in detection or reporting methodology. This has been driven by a reduction in the incidence rate of *first* cases of clinical mastitis, in particular the rate at which cows were detected and reported with a first case of clinical mastitis after the first 30 days of lactation, which reduced from 3 in 12 cows affected for the 12 months to the end of 2019 to 1.7 in 12 cows affected for the 12 months to the end of 2023 (target less than 2 in 12 cows affected). Comparing the 12 months ending December 2019 with the 12 months ending December 2023, the estimated recoverable cost from improved control of clinical mastitis in the herd is close to £20,000, or around 1 penny per litre. Finally, the reduction in herd mastitis control has played a part in the reduction in overall amount of mg of antibiotic

used per Population Correction Unit (PCU), reduced from 20.7mg/PCU to 11 mg/PCU over a three year period, with similar reductions in the average Defined Daily Dose (DDD) of antibiotic (from 4 to 2.5 daily doses over the same period) and average Defined Course Dose (DCD) of antibiotic (from 1.55 to 1.03 courses over the same time period).

Implementation of AHDB Dairy Mastitis Control Plan provides a structured approach to mastitis control and combined with the REMEDY mastitis Pattern Analysis Report and AHDB QuarterPRO resource materials, provides a package for monitoring and continuous improvement of udder health in the UK dairy herd.

INTRODUCTION AND BACKGROUND

The AHDB Dairy Mastitis Control Plan (DMCP) was launched in 2008 following publication of a randomised controlled trial that showed a significant decrease in the proportion of cows affected with mastitis for those herds that received a structured, specific plan compared to control herds that did not receive this approach (1). The DMCP was subsequently rolled out to more than 1000 herds between 2009 and 2012 during a period of close support from the original authors of the research and funding from AHDB Dairy.

The initial progress with the scheme and some of the challenges faced have been reported elsewhere and a full report of the first three years of the scheme is available online (2). After the initial three-year period, the impact of the DMCP was monitored for a further three years between 2013 and 2016, although this relied heavily on individual trained Plan Deliverers to feedback data and Plans; these were subsequently anonymised and analysed. The overall estimated benefits of implementing the DMCP in herds has been calculated at approximately £40 per cow in herd per year, after costs of implementation have been deducted (3). This approach has continued to be used by veterinary surgeons and consultants who have been trained to deliver the DMCP, which has become recognised as a route to mastitis control by the industry, milk buyers and retailers. Improvement in herd mastitis control is also likely to have significant benefits in the reduction of both intra-mammary and/or parenteral antibiotic use if control of new intra-mammary infections in the herd is reduced (4); a previous case report delivered to the British Mastitis Conference by the author highlighted the impact of the DMCP on herd antimicrobial use (AMU) (5).

In recent years, there has been renewed interested in the analysis of individual cow somatic cell count and clinical mastitis event data and how this maybe automated to assist DMCP deliverers working with herds. This is particularly important, as the assessment of the predominant herd mastitis infection “pattern” remains a fundamental starting point for implementation of structured mastitis control Plans. Research using data from 1000 herds, investigated the development of algorithms to replicate the herd "diagnosis" process involved in inspection of herd mastitis data, and these algorithms were subsequently found to have a high degree of accuracy when compared to specialist veterinary surgeons (6). This research has since been incorporated into the mastitis Pattern Analysis Report and provided via REal tiME DairY ('REMEDY', a data analytics platform developed by QMMS Ltd and the University of Nottingham funded through Innovate UK; https://gtr.ukri.org/projects?ref=48717), and provides a rapid and automated approach for veterinary surgeons and herd advisors to assess the current herd mastitis pattern (7).

This paper presents an ongoing herd case report where implementation of the DMCP alongside use of the mastitis Pattern Analysis Report has seen significant benefits in terms of clinical mastitis reduction. Discussions were had during the autumn and winter of 2020 in response to concerns regarding the incidence rate of clinical mastitis. Initial analysis of data is presented as well as key interventions and follow up from 2020 onwards.

DATA ANALYSIS (2019-2020)

Somatic cell count (SCC) and clinical mastitis data were downloaded from the milk recording organisation in CDL format (National Milk Records, Chippenham, UK) and analysed using the TotalVet software (QMMS Ltd). Data for the calendar year 2019 and the first nine months of 2020 were inspected to gain insight into the predominant infection pattern. Initial analysis is shown in Table 1.

Regarding the somatic cell count data, the 12-month average cell count was close to 200,000 cells/ml, with some variation in individual herd test-days depending on time of year. Whilst prevalence of infection was around 20% of the cows infected, the relative importance of dry period origin infections (*i.e.* proportion of those cows dried off below 200,000 cells/ml and first calving heifers that are recorded >200,000 cells/ml at the first test-day post-calving) appeared to be less in the previous 12 months (average 16%, target less than 10%), suggesting some improvement in this area of management.

The clinical mastitis event data was particularly important given the herd owners request for a meeting, and the overall incidence rate was increased at 60 quarter cases per 100 cows/year for the 12 months to the end of September 2020, putting this herd well above a mean incidence rate of 23 cases per 100 cows/year for herds quoted from the AHDB Dairy Sentinel Herds project (7). The index (new) case rate in the first 30 days of lactation (*i.e.* these cases are likely to arise as a result of dry period origin infections) had decreased in the last 18 months, and was averaging below the target of 1 cow affected for every 12 cows eligible in the last three months to September 2020; in contrast, the rate of new cases in cows *more* than 30 days in milk (*i.e.* likely lactating period origin) remained increased above target, averaging more than 2 in 12 cows affected in the previous 12 months.

Table 1: Mastitis key performance indicators at Mount Pleasant Farm (September milk recording 2020).

Parameter	Rolling 3-recording average	Rolling annual average	Target
Herd average SCC (‘000 cells/ml)	216	181	<200
% herd >200,000	20.9	21	<20
% herd chronic*	13.5	13.7	<5
Dry period cure rate (%)	84.2	81	>85
Dry period new infection rate (%)	18.4	16.1	<10
Lactation new infection rate (%)	7.8	8.3	<5
Clinical mastitis rate (quarter cases per 100 cows/year)	63	60	<25
Dry period origin 1st cases (per 12 cows at risk)	0.7	1.14	<1
Lactating period origin 1st cases (per 12 cows at risk)	2.75	2.43	<2

* **Proportion of cows with more than one of the last three SCC>200,000 cells/ml**

Clinical mastitis samples collected and submitted for bacteriological analysis to an independent, specialist laboratory (QMMS Ltd, Wells, UK) confirmed the predominance of environmental Gram-negative aetiology in the previous 12 months, with 10 of 16 samples submitted revealing the presence of *E. coli* in pure growth or in combination with other environmental major pathogens (Table 2).

Based on the output of the mastitis Pattern Analysis Report (Figure 1) the clinical mastitis event data and clinical mastitis bacteriology, a presumptive herd mastitis pattern ‘diagnoses was made of predominantly **environmental** mastitis of **lactating** period origin given the likely improving dry period origin infection situation.

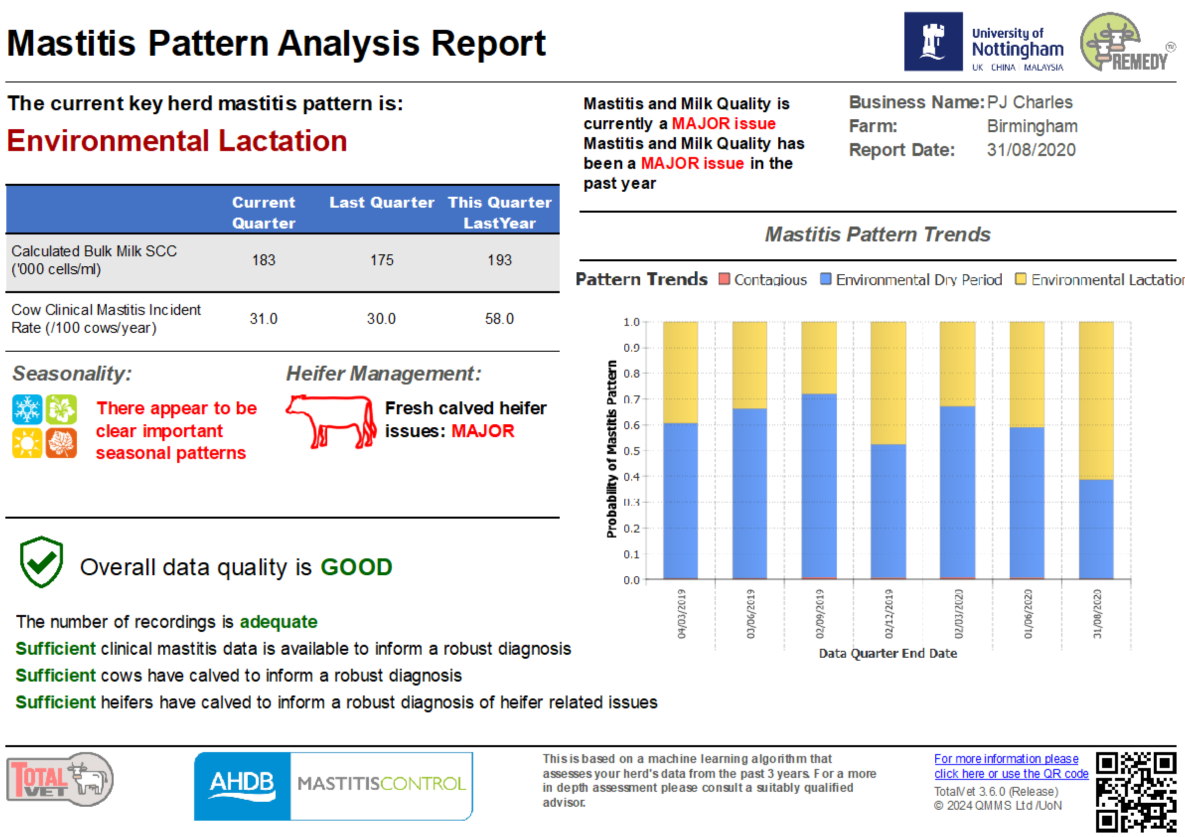
Table 2: Clinical Mastitis Bacteriology (QMMS Ltd, Wells, UK).

Date	Cow ID	DiM	Result
UK	347	225	Mixed, heavy growth of *Kluyvera intermedia* and *Lactococcus lactis*
UK	122	38	Mixed, heavy growth of *Raoultella ornithinolytica* and *Lactococcus lactis*
UK	132	UK	Mixed, heavy growth of *Streptococcus dysgalactiae* and *Geotrichum silvicola.*
21/12/2018	148	UK	Mixed, heavy growth of *Serratia marcescens* and *Pantoea agglomerans*
31/12/2018	316	UK	Heavy, pure growth of *E. coli*
02/08/2019	287	25	Scant, pure growth of *E. coli.*
16/08/2019	97	45	Scant growth of *E. coli.*
19/08/2019	42	60	CONTAMINATED SAMPLE
20/08/2019	327	134	Heavy growth of *E. coli.*
20/08/2019	315	24	Mixed, heavy growth of *E. coli* and *Candida rugosa.*
10/12/2019	151	7	Heavy growth of *E. coli.*
11/12/2019	154	4	Heavy growth of *Streptococcus uberis*
05/06/2020	130	UK	Heavy growth of *E. coli.*
07/07/2020	228	UK	Mixed, heavy growth of *Streptococcus uberis* and *E. coli.*
07/07/2020	154	UK	Mixed, heavy growth of mucoid *Streptococcus uberis* and scant growth of *E. coli.*
12/07/2020	189	UK	Heavy, pure growth of *E. coli.*

MASTITIS PATTERN ANALYSIS REPORT (AUGUST 2020)

The mastitis Pattern Analysis Report was generated using the August milk recording data and a complete month of clinical mastitis event data prior to the author's visit to the farm in September 2020. The mastitis Pattern Analysis Report tool output showed a pattern of predominantly environmental mastitis infection of lactating period origin for the last three months ('current'), and no evidence for a significant 'contagious' mastitis infection pattern (Figure 1).

Figure 1: Mastitis Pattern Analysis Report output using individual cow somatic cell count and clinical mastitis data (August 2020). https://cloud.remedy.farm/dashboard/#/signup-mro



IMPLEMENTATION OF THE PLAN: OBSERVATIONS AND QUESTIONS

The DMCP software ('ePlan', SUM-IT Computers, Thame, UK) was used to generate the full DMCP questions and observations, and these were worked through with the herd owner. Areas covered included lactating and dry cow environment management, milking routine, basic milking machine function, treatment, biosecurity, youngstock management and monitoring. The aim was to capture current herd management and husbandry practices that may be relevant to mastitis control, for example frequency of bedding in dry cow yards, pre-milking teat preparation routine, stocking rate in cubicle housing *etc*. In all, more than 350 questions and observations were asked or made. All responses were captured electronically as a series of Yes/No responses, entered into the ePlan software and the Plan 'locked' to prevent further amendment. **Finally, a herd diagnosis of 'environmental' infection patterns of predominantly 'lactating period origin' was entered.**

IMPLEMENTATION OF THE PLAN: SELECTION OF CONTROL PRIORITIES

Following entry of the herd mastitis pattern the ePlan software was used to filter out areas of management not directly related to the herd diagnosis (*i.e.* any deficiencies in dry cow management were initially ignored). This stage resulted in removal of 'incorrect' responses, leaving only those items that directly related to the current herd mastitis pattern. From these, clinical judgement was used to prioritise six of these for discussion with the farm. Overall priorities put forward are shown in Figure 2 and summarised as follows:

1. MUST remove cubicle building ridge cap to improve outlet ventilation and "stack effect" function (reduce environmental pathogen survival),
2. Cubicle beds to be bedded with new, clean, dry sawdust and lime TWICE daily in summer months (reduce environmental pathogen load),
3. Collecting yard area MUST be scraped out before or after every milking (reduce environmental pathogen load on entry to the parlour),
4. Review provision of outdoor "living space" for the early lactation cow group (reduce environmental pathogen load),
5. Review pre-milking teat disinfection to incorporate dry wipe prior to unit attachment (reduce environmental pathogen load),
6. Increase liner change frequency (reduce pathogen survival).

Figure 2: AHDB Dairy Mastitis Control Plan for Mount Pleasant Farm in 2020

AHDB Mastitis Control Plan

Pete and Emma
Plan Created on: 30/09/2020

Section 1 - General Farm Information					
Qu	19.	There SHOULD be water trough space of >10cm per cow for all cows at all stages of the production cycle, including availability in the yards before and after milking.			
Section 2 - The Milking Herd Between Milkings					
Qu	31.	There SHOULD be 5% more cubicles than cows for each group.			
Qu	33.	Inorganic bedding materials SHOULD be used wherever possible.			
Ob	56.	There SHOULD be at least 3sq.m. per cow.			
Ob	57.	There MUST be good ventilation, but without draughts in all milking cow housing.			
Ob	59.	There SHOULD be at least 0.6m feedspace per cow in total for access to forage, concentrate or complete diet portions of the cows' feed.			
Section 3 - Pre-Milking Management					
Qu	85.	Collecting yards MUST be scraped before or after every milking.			
Section 4 - The Milking Routine					
Qu	103.	Irrespective of its use, only potable water MUST be used in the parlour.			
Ob	110.	20 to 30 seconds MUST elapse after application of pre-milking teat disinfection, before teats are dried.			
Section 5 - The Milking Plant					
Calc'd		Liners MUST be changed at least every 2500 milkings or 6 monthly (whichever occurs first) - unless the manufacturer specifies otherwise.			

Following initial discussions, the farm owner began to put in place some of these control measures, particularly teat preparation and cubicle bedding management, and a cycle of feedback based on monitoring of the clinical mastitis and cell count data every 3 months or so coupled with telephone discussions around management continued.

A follow up meeting with the farm and the herd's own veterinary surgeon in 2021 discussed other management items, particularly outlet ridge ventilation and skylights, the feasibility of switching to deep sand cubicle housing for the early lactation cow group, availability of outside "living space" and whether or not low yielding, late lactation cows continue to be offered grazing in summer months (high rate of first cases observed even in these cows in summer suggesting risk of infection at pasture).

These latter discussion points were addressed with a project to convert the fresh cow loose yard to a small deep sand cubicle area (although widespread adoption of deep sand bedding has not been carried forward), the outlet ventilation was provided following removal of ridge caps and some skylights blocked following installation of solar panels (although other skylights remain), outside living space was made available to the early lactation cow group approx. 2m^2 per cow) using the "concourse" area used for cows post-milking and finally the decision was made to full house all lactating cows and therefore low yielding, late lactation cows remained cubicle housed in summer.

OUTCOME AND DISCUSSION

The summary clinical mastitis and cell count figures for 2023 are shown in Table 3.

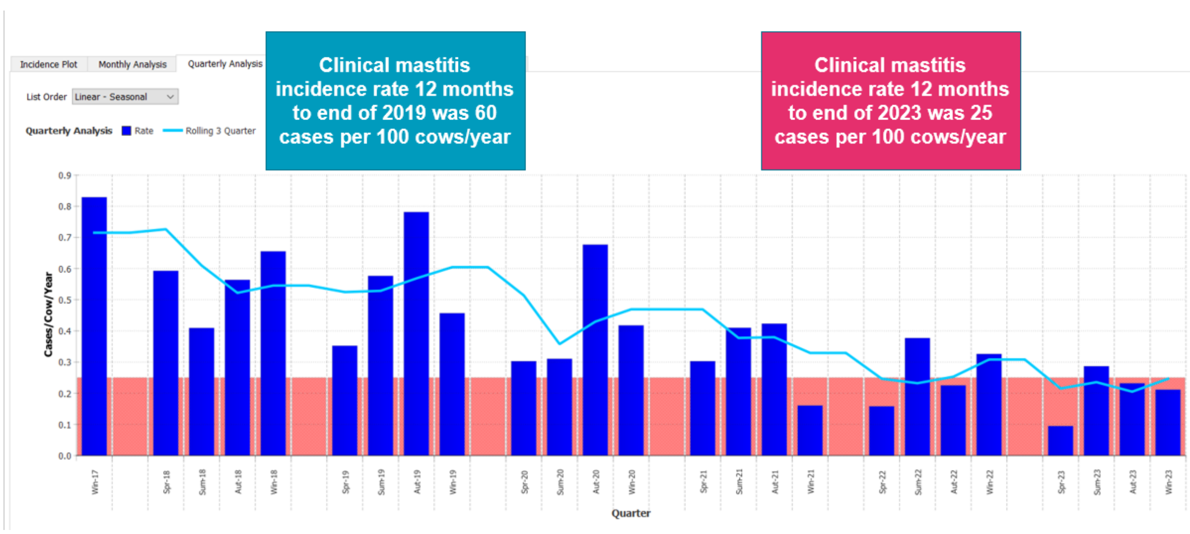
Table 3: Mastitis key performance indicators at Mount Pleasant Farm (September milk recording 2023).

Parameter	Rolling 3-recording average	Rolling annual average	Target
Herd average SCC ('000 cells/ml)	185	172	<200
% herd >200,000	14.9	15.5	<20
% herd chronic*	9.4	9.9	<5
Dry period cure rate (%)	80	76.1	>85
Dry period new infection rate (%)	7.1	9.8	<10
Lactation new infection rate (%)	6.2	5.6	<5
Clinical mastitis rate (per 100 cows/year)	20	25	<25
Dry period origin 1st cases (per 12 cows at risk)	0.54	0.48	<1
Lactating period origin 1st cases (per 12 cows at risk)	1.61	1.79	<2

The herd average SCC has remained relatively unchanged, highlighting the relative difficulty in using this as a sensitive outcome measure particularly in the early periods of implementing the DMCP. More important is the relative improvement in the lactation *new infection rate* (*i.e.* proportion of cows moving from <200,000 cells/ml to >200,000 cells/ml between consecutive milk recordings in lactation), which has fallen steadily through the last three years from a rolling 12-recording average of 8.3% in September 2020 to just 5.6% for the 12-recording average to September 2023, close to the target of <5%.

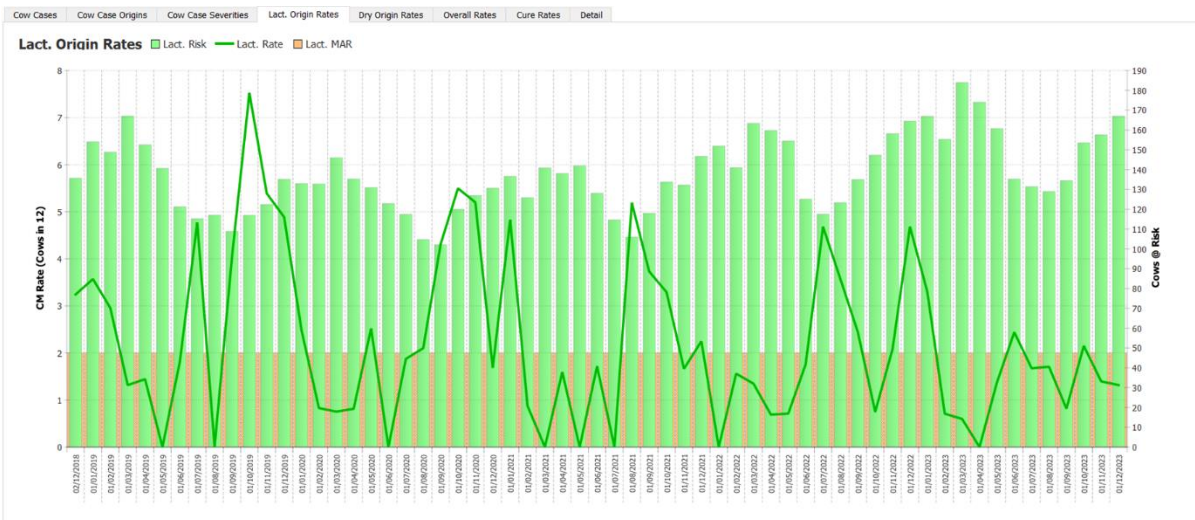
Most importantly, the overall clinical mastitis rate has fallen in the last three years or so, reaching the equivalent of 25 cases per 100 cows/year to the end of 2023 (Figure 3). The reduction in clinical mastitis rate was driven by an overall reduction in the rate at which cows were reported with a first clinical case of mastitis after 30 days in milk, falling from more than 3 in 12 cows affected in 2019, to 1.7 cows in 12 affected on average for the calendar year 2023, with some improvement in summer months, particularly during summer 2023 (Figure 4).

Figure 3: Incidence rate of clinical mastitis events for period 2019 to 2023. Blue bars and blue line show the incidence rate for spring, summer, autumn and winter and a rolling nine-month average respectively relative to an orange target zone of 25 cases per 100 cows/year equivalent (©TotalVet, QMMS Ltd).



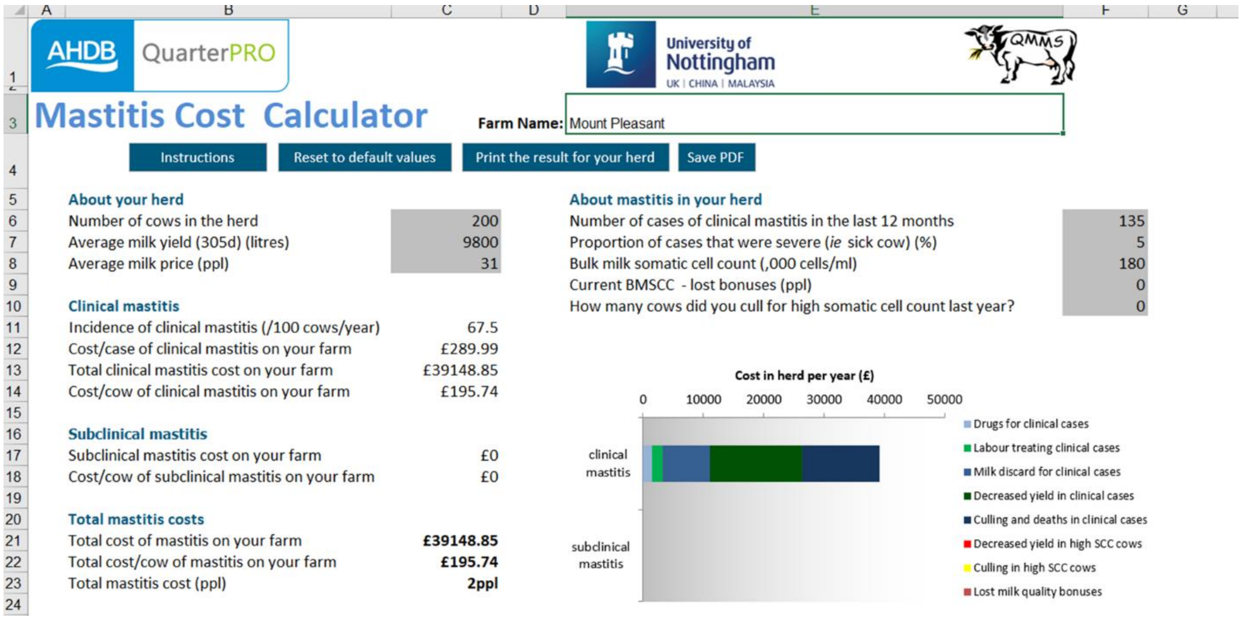
The current herd mastitis Pattern Analysis Report continues to show the relative importance of environmental lactating period infection, given the excellent control of dry period and contagious infection patterns in this herd. Longer term projects such as robot scrapers (installed in late 2023), installation of more fans and painting out the remaining skylights (for 2024) and even robotic milking and a complete overhaul of building design to re-think feed and water access per cow as well as cubicle comfort and lying times mean that mastitis control remains on the herd health agenda.

Figure 4: Lactating period origin FIRST clinical mastitis incidence rate. Green bars show the population of cows 'at risk' of a clinical mastitis event (more than 30 days in milk), green line shows the actual rate of first cases relative to the orange target zone of no more than 2 in 12 cows affected. (©TotalVet, QMMS Ltd)



Finally, cost benefit analysis using the simple calculator provided on the AHDB Mastitis Control Plan web page (https://mastitiscontrolplan.co.uk/qpro-tools) shows *recoverable* costs in the order of £19,000 and a saving of around 1 pence per litre when we compare the situation in 2019-2020 with that of 2023-2024 (Figure 5). Alongside this, there has been a reduction in the total mg of antibiotic used per Population Correction Unit (PCU) from nearly 21mg/PCU to 11 mg/PCU and a reduction in the average Daily Defined Dose (DDD) of antibiotic from 4 to 2.5 doses per cow (Figure 6).

Figure 5: Cost benefit analysis using simple cost calculator tool comparing 12 months to end of 2019 with the 12 months to the end of 2023. (https://mastitiscontrolplan.co.uk/qpro-tools)



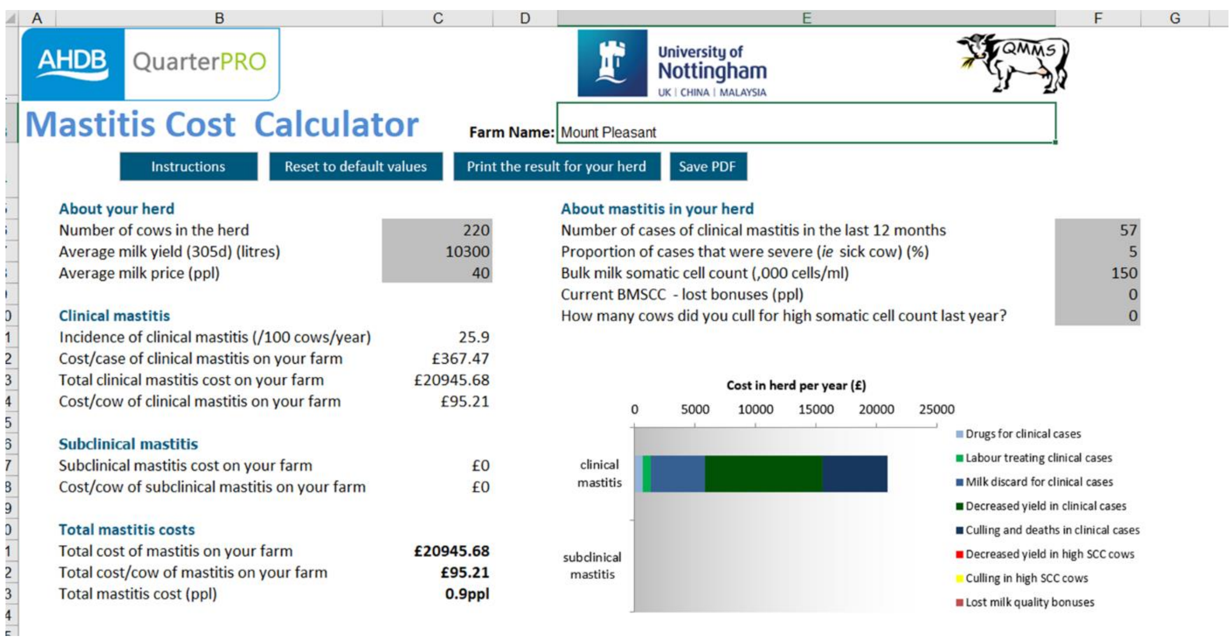
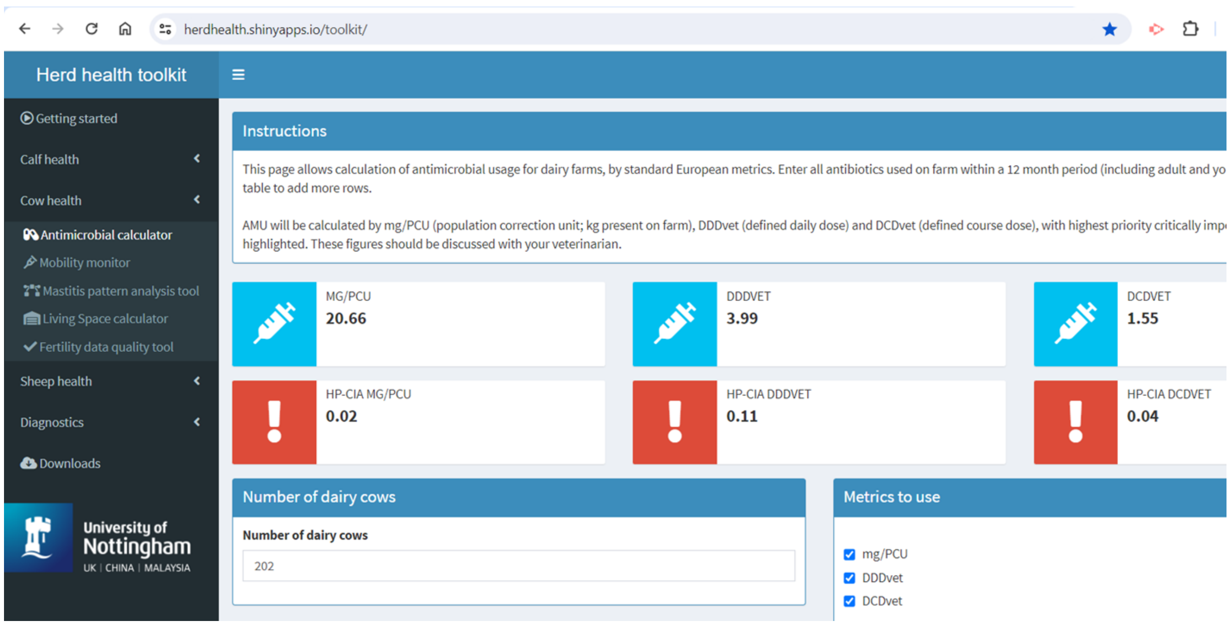
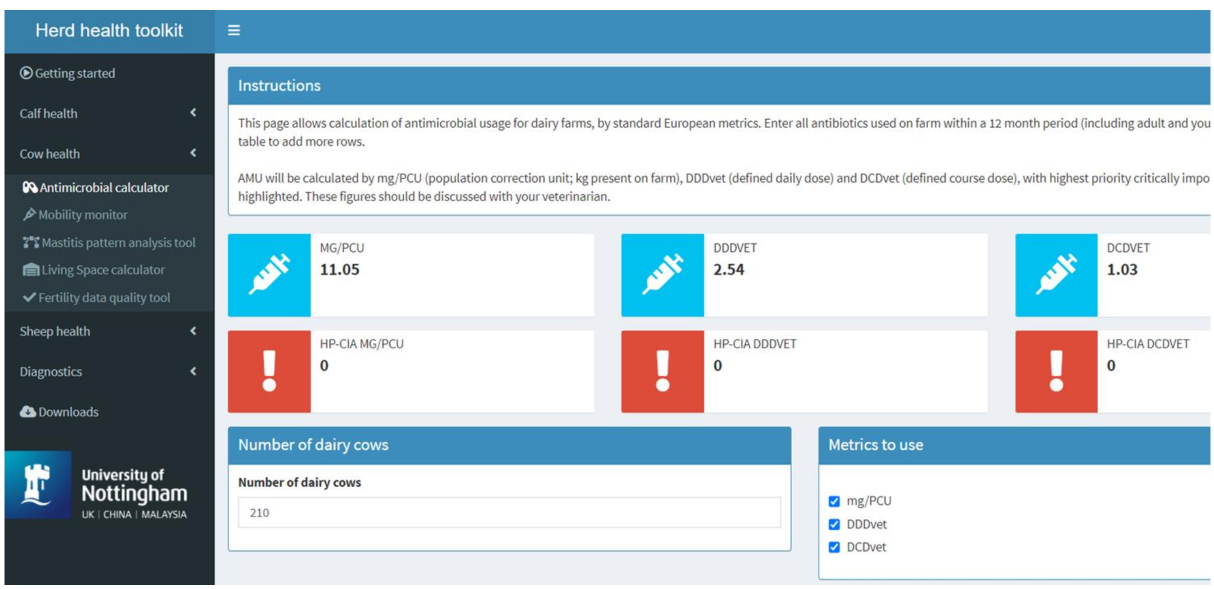


Figure 6: Antimicrobial Use (AMU) breakdown comparing 12 months ending August 2021 (top) with the 12 months ending April 2023 to show itemisation of antibiotic use metrics (mg/Population Correction Unit, Defined Daily Dose (DDD), Defined Course Dose (DCD) https://herdhealth.shinyapps.io/toolkit/)





In conclusion, the implementation of a structured approach to mastitis control reduces new intra-mammary infections and clinical mastitis incidence rate and leads to a reduction in antibiotic use.

Environmental mastitis infection patterns during lactation are common and often require a combination of management changes, including housing, space, ventilation, and bedding management as well as teat preparation.

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NOTES

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REVISION OF ISO STANDARDS FOR MILKING MACHINES

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INTRODUCTION

Standards (1) are the distilled wisdom of people with expertise in their subject matter and who know the needs of the organizations they represent – people such as manufacturers, sellers, buyers, customers, trade associations, users or regulators.

This poster provides an update on the currently underway revision and update of ISO standards relating to milking machines.

INTERNATIONAL STANDARDS ORGANISATION (ISO)

ISO, the International Organization for Standardization (2), brings global experts together to agree on the best way of doing things – for anything from making a product to managing a process. As one of the oldest non-governmental international organizations, ISO has enabled trade and cooperation between people and companies the world over since 1946. The International Standards published by ISO serve to make lives easier, safer and better.

ISO has produced 25351 standards which are adopted by 171 member countries.

The British Standards Institution (BSI) (3) is recognised as the National Standards Body and is the ISO Member Body representing the UK.

Preparation of International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental also participate, as appropriate. In the context of Milking Machine Standards, key contributors include the International Dairy Federation, researchers, users, advisers and consultants. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Four standards are specific to Milking Machines (8) for cows, water buffaloes, sheep and goats where animals are milked with pulsation created by vacuum, and where milk is, at least partly, transported with the help of airflow. Some clauses are not applicable to all types of milking machines. The qualitative requirements also apply to installations for milking other mammals used for milk production.

HISTORY OF STANDARDS FOR MILKING MACHINES

There have been local, and manufacturer specific, standards in use for milking machines for many years. The earliest recognisable national standard appears to be CP 3007:1968 (4). This document was a Code of Practice, rather than a national standard. British Standards for milking machines have been harmonised with ISO standards since the 1970's and routinely been revised and updated (5,6,7,8).

SCOPE OF MILKING MACHINE STANDARDS

The scope set out in CP 3007 (4) provided a foundation for later generations of the standards and states "This code lays down requirements and offers recommendations to inform dairy farmers, implement agents or dealers, manufacturers of milking machines and other interested parties concerning basic principles for the installation and maintenance of milking machine equipment".

The scope of the current standards states "This International Standard specifies the minimum performance and information requirements and certain dimensional requirements for satisfactory functioning of milking machines for milking and cleaning. It also specifies minimum requirements for materials, design, manufacture and installation".

REVISION OF MILKING MACHINE STANDARDS

ISO standards are reviewed routinely every 5 years to determine if they remain relevant or require revision or withdrawal. Following the 2022 review, member countries voted for revision of the Milking Machine Standards (8). The revision is currently being undertaken by a working group of representatives from a number of member countries.

The scope has been revised to recognise that a certain technical design alone cannot guarantee a satisfactory outcome. Satisfactory outcome is determined by the milking system's ability to maintain adequate and intended average vacuum in the claw and/or teatcup liner during milking and the ability of the pulsation system to operate within the manufacturer's specifications. The revised standard will refer to Bulletin of the International Dairy Federation 396/2005 for complete evaluation of milking performance, including non-machine related aspects.

A major element of the revision is to specify milking-time tests, performed while milking cows and with the milking system under normal use conditions, to provide the best means of demonstrating the adequacy of the vacuum production and regulation function of any milking system.

The revision also recognises that many milking systems, both Automatic and Conventional, are in continual use. In this respect alone, milking performance testing is required for evaluation of compliance with manufacturer's specification.

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INVESTIGATIONS INTO THE EFFECTS OF THE DURATION OF THE C-PHASE OF PULSATION IN MILKING PERFORMANCE

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SUMMARY

Claims have been made that reducing the duration of the c-phase of pulsation, or slowing the rate of vacuum change during the c-phase will improve milking performance by improving cow comfort during milking. Increased milking speed has been presented as support for this hypothesis. This hypothesis was investigated with a review of literature on the relationship between pulsation phase duration, liner wall movement, the point in the pulsation cycle where milk flow starts and stops, and the documented effects of altering the c-phase of pulsation. Increased milking speed resulting from increasing c-phase duration can be explained by changes in milk:rest ratio and there is no need to resort to unproven speculation regarding cow comfort for this effect. The optimal duration of the Milk and b-phase of pulsation is dependent on both liner compression (as indicated by overpressure) and the milking vacuum level (7). The type of liner and teatcup should be considered when choosing the milking vacuum and pulsator settings as they are all part of an interactive system. An investigation of teat end congestion after milking will reveal if the massage produced by the liner can support the combination of milk-phase duration and teat-end vacuum level.

LITERATURE REVIEW

A study on liner wall movement (1) reported that the duration of liner closing was 63% of the a-phase duration and the duration of liner closing was 40% of the c-phase duration. The start of milk flow (3 in Figure 1) occurs when the liner has relieved sufficient pressure on the teat end for the canal to open. The stop of milk flow (7 in Figure 1) occurs when the liner applies sufficient pressure on the teat end to close the canal. The pulsation chamber vacuum at the start and stop of milk flow from the teat end are approximated by measurements of liner overpressure (2). The ratio of the time that milk is flowing to the total pulsation cycle is referred to as the “true” milk:rest ratio. A recent study (3) showed that there was a clear increase in teat end congestion for d-phase durations less than 150 ms, and that there was no benefit of d-phase duration greater than 200 ms, regardless of liner type or milking vacuum level.

A paper often used to suggest that the duration of the c-phase has some physiological consequence (4) reported that there was no effect of changing vacuum-decrease time (c-phase duration) on milking. A subsequent paper (5) concluded that the duration of a and c phases had no effect on udder health or teat end condition and that an 8% increase in the percentage of the c phase resulted in an 8% increase in in average milk flowrate (AMF) and a 5% increase in peak milk flowrate (PMF). This paper postulates that it is possible that short phases induced animal reactions because of faster movement of the liner. Similar results were reported (6) in which a 6% increase in percentage of the c phase resulted in a 5% increase in AMF and 7% increase in PMF. While it was speculated that these increases in milking speed may have been due to improved cow comfort, there was no evidence other than milk flowrates to substantiate the claim.

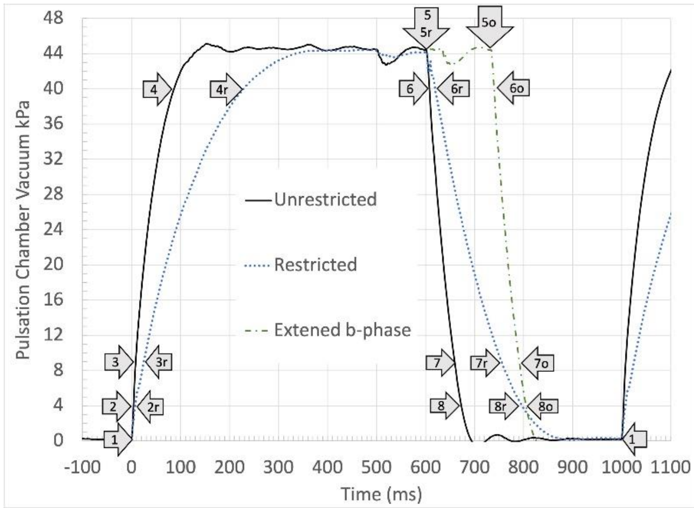
METHODS AND RESULTS

Wet tests, using a teatcup with triangular liner and small pulsation chamber volume and an artificial udder with water flowing through teatcups. In the unrestricted scenario the milk:rest ratio is considerably higher than both the pulsator and pulsation ratios. In the restricted scenario restrictors were fitted to the pulsation tubes to slow down the a and c-phases of pulsation. The extended c-phase moves the stop of milk flow (7r) resulting in a milk:rest ratio of 73:27. The increase in the milk:Rest ratio for the restricted condition would be expected to increase milk flow rate by about 12% when compared to the unrestricted condition. Similar results for the unrestricted condition can be achieved by increasing the ratio to extend the b-phase. The resulting milk:rest and milk flowrate are the same as the restricted case – and does not rely on added parts that can be damaged or lost, increase risk of plugging, or rely on unproven theories of discomfort. Further improvement can be made by adjusting both the rate and ratio to optimize the d-phase (not shown in Figure 1), as studies have shown no benefit in a d-phase longer than 200 ms (3).

Table 1. Wet test of pulsation.

	Un-restricted	Restricted	Extended b-phase	Optimal d-phase
Pulsator Rate	60 ppm	60 ppm	60 ppm	63 ppm
Pulsator Ratio	60:40	60:40	68:32	72:28
a/b/c/d (ms)	88/513/67 /332	219/381/177 /211	88/593/67 /252	88/593/67 /200
Milk/Rest (ms)	650/40	730 / 270	730 / 270	730 / 218
Milk:Rest Ratio	65:35	73:27	73:27	75:25
Flowrate Change	Base	+12%	+12%	+15%

Figure 1 Wet tests of pulsation chamber vacuum. *1=pulsator opens, 2=start of a-phase, 3=start of milk flow, 4= start of b-phase, 5=pulsator closes, 6=start of c-phase, 7=milk flow stops, 8=start of d-phase.*



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A PRACTICAL APPROACH TO THE SELECTIVE TREATMENT OF CLINICAL MASTITIS (STCM)

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SUMMARY

The increased availability of farm data and cow-side testing facilitates treatment decision making for cases of clinical mastitis. The selective treatment of clinical mastitis (STCM) is aligned with the responsible use of antibiotics without compromising on cow health and welfare[1]. Using a framework from the scientific literature[2], a practical approach to applying STCM in UK dairy herds is presented.

STEP 1

Determine herd suitability for selective treatment of clinical mastitis with your vet:

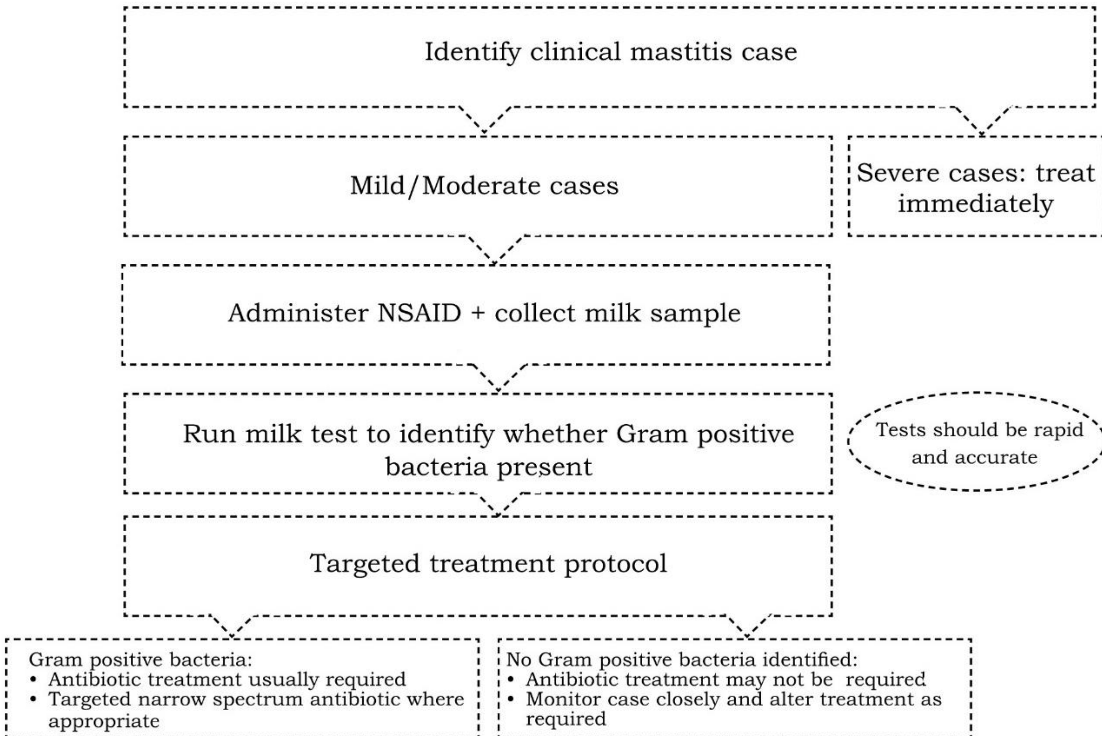
Mastitis Pattern Analysis eg AHDB QuarterPro	Bacteriology of clinical mastitis cases - representative samples	Clinical Mastitis Data

Herds suitable for STCM include those with good clinical mastitis data (ideally at quarter level), and herds where the mastitis pattern analysis and bacteriology is consistent with clinical mastitis caused by the common major or minor mastitis pathogens. The presence of less common pathogens, including Klebsiella spp or Mycoplasma spp, could make a farm unsuitable for STCM and an individual prevention and treatment programme should be implemented. Your vet is able to use all of the available herd information and data to reach this decision.

STEP 2

All farms - Mastitis prevention
All farms should focus on mastitis prevention with their vet using the data and information available. The AHDB Mastitis Control Plan is a proven, structured, evidence-based and wide-ranging approach to mastitis prevention and control in dairy cattle.

Suitable farms - Selective treatment of clinical mastitis



Opportunities for engagement and discussion on farm:

Identification of cases of clinical mastitis	Use of NSAID	Treatment protocols

STEP 3

Regularly monitor new infection rate, treatment outcomes / cure rates and review with your vet. Ensure all clinical cases are recorded, including those that do not receive antibiotic treatment.

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Proceedings of the British Mastitis Conference (2024) Sixways, Worcester, p 72 - 73
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BACTERIAL SPECIES PREVALENCE IN CLINICAL MASTITIS SAMPLES: AN ANALYSIS OF DATA OVER TWO YEARS

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It is widely understood that not all cases of mastitis require or respond to antibiotic treatment. On-farm diagnostics are rapidly becoming the standard mechanism for ensuring mastitis cases requiring treatment are identified, and antibiotics used prudently.

Mastatest is an innovative on-farm diagnostic for bovine mastitis that can identify the bacterial species within a milk sample, and test for antibiotic sensitivity of the strain identified. It simplifies sample preparation for farmers using a patented cartridge system that takes seconds to fill. Samples are poured into the easy-to-use cartridge and placed in the Lapbox hardware device for automated sample processing and analysis. Results and a treatment recommendation are interpretated using cloud analytics and returned to the farm (and their vet) via email and in an online portal within 24hrs.

A summary of all clinical mastitis samples tested on the Mastatest platform in the United Kingdom between 1 May 2023 and 30 April 2024 was downloaded by Mastaplex, and analysed using standard reporting tools available within the Mastatest online portal. This data ("2024 data") was compared with that previously reported by Saila and colleagues for the preceding 12-month period ending 30 April 2023 ("2023 data")[1].

The total number of samples in the 2024 data was 4590 (compared with 1616 in the 2023 data). The pattern of bacterial species identified in samples within the dataset was however remarkably stable.

The 2024 dataset showed 12% of all samples had no bacterial growth (-4% vs 2023 data). Focussing on key gram-negative species, 26% of all samples contained *E. coli* or other gram-negative bacteria (+2% vs 2023 data), and 2% contained *Klebsiella/Serratia* (no change).

Taken together, a farmer utilising Mastatest would be able to rule out the need for antibiotic treatment in 40% of all presenting clinical mastitis cases.

Antibiotic sensitivity testing confirmed that those samples where *E. coli*/other gram-negative, or *Klebsiella/Serratia* were the causative bacteria, 100% were identified as having a low chance of responding to benzylpenicillin or cloxacillin (Minimum Inhibitory Concentration (MIC) = 4 or >4), and >98% were identified as having a low chance of responding to cephalexin. This data continues to reinforce that treating these mastitis cases with antibiotics is not likely to be beneficial.

Other common bacteria identified (reported as 2024 data, and change from 2023 data) were *Strep. uberis* (16%, +4%), *Strep. dysgalactiae* (4%, +2%) other *Strep.* species (6%, -4%), other gram-positive (8%, no change), *Coagulase negative staphylococci* (8%, -2%), and *Staph. aureus* (4%, no change).

Detailed data on antibiotic sensitivity again showed, similar to the 2023 data, that for most bacterial species there is no 'one-size-fits all' choice of optimal antibiotic. This supports the rationale of having sensitivity data to inform the correct selection.

Ten percent (10%) of samples were found to have more than one bacterial species present, a decline of 6% on the 2023 data. This could indicate improvements in milk sampling technique as farm teams become more familiar with on-farm testing.

Data from the expanding Mastatest cohort of clinical mastitis samples within the UK presents a unique and ongoing opportunity to understand the causes of mastitis and ensure the most effective treatment and management plans are being implemented on-farm.

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Proceedings of the British Mastitis Conference (2024) Sixways, Worcester, p 74 - 76
The Dairy Group, The University of Nottingham, BCVA & QMMS

FREEZER STORAGE IMPACT ON CLINICAL MASTITIS CULTURE RESULTS

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Current guidelines for storage of clinical mastitis samples prior to culture vary depending on the source. A 2×2 factorial design experiment was conducted to assess the impact of factors temperature (-20°C and -80°C) and duration (1 week and 1 month) on mastitis milk samples and their culturability, in comparison to a fresh control aliquot. The impact of freezing differed dependent on the pathogenic agent present. Gram-positive bacteria were not altered by freezing at either temperature or duration. Gram-negative bacteria were not culturable at the 1-month timepoint at either temperature and had reduced culturability following 1 week at -80°C. Yeasts were not culturable following freezing at any temperature and duration. These results suggest that clinical mastitis samples should be cultured fresh to obtain the most accurate results.

INTRODUCTION

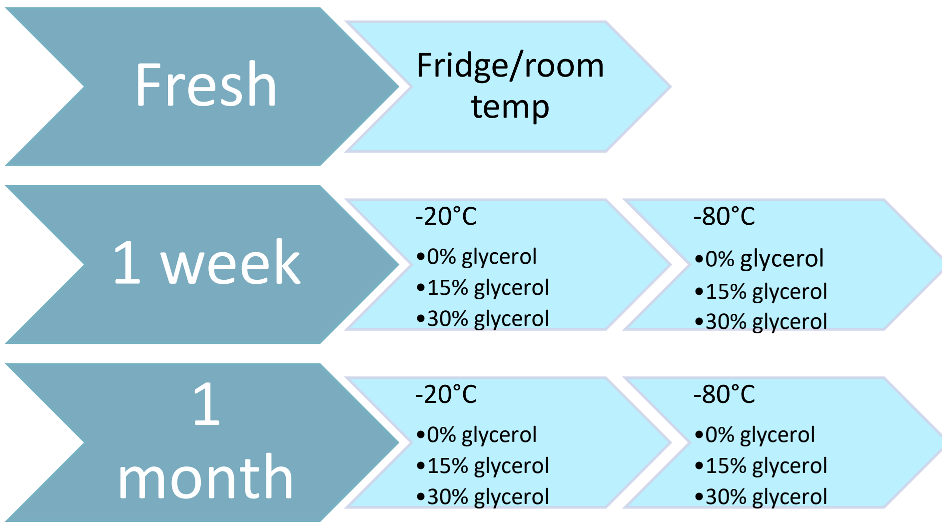
In cases of clinical mastitis, it is commonly recommended to diagnose the causative pathogen via culture to ensure appropriate treatment. Different animal health organisations recommend a maximum freezer storage time of anywhere between four to six months (1,2). However, in practice, it is not uncommon for samples to be left for much longer before being sent for culture. The aim of this trial was to investigate the impact of freezing clinical mastitis samples at different temperatures and for different durations on culture results.

MATERIALS & METHODS

To date, 11 cases of clinical mastitis have been included in this trial. Samples were collected following National Mastitis Council aseptic collection guidelines by staff at SRUC's Crichton Royal Farm, following identification of disease and prior to antibiotic administration. Samples were split evenly into aliquots for the different storage methods (Fig 1). Glycerol was added to two samples at 15% and 30%, in addition to the temperature and duration factors, to test its potential as a cryopreservant agent.

Diagnostic culture of mastitis pathogens was performed by SRUC Veterinary Diagnostic Services using Blood, MacConkey, and Edwards agar, and MALDI-TOF mass spectrometry where appropriate.

Figure 1 Freezer duration, temperature, and glycerol addition flow chart for each mastitis milk sample aliquot prior to culture



RESULTS

Of the 11 cases, seven produced a positive (i.e., non-sterile) culture from the control aliquot. Gram-positive bacteria accounted for five out of seven of the positive cases, with the other two being a mixed growth of a Gram-negative bacteria and yeast, and the final being a mixed growth of Gram-positive and Gram-negative bacteria. The most common bacteria identified was *Streptococcus dysgalactiae*.

Gram-positive bacteria were unaffected by freezing at either temperature for either duration. Gram-negative bacteria were unculturable after 1 month of freezer storage at both temperatures and had decreased culturability when stored at -80°C for 1 week. Yeast was not culturable after any freezing, regardless of temperature or duration. Samples preserved with glycerol produced Gram-positive bacterial cultures at both temperatures, durations, and glycerol concentrations, including 0% (i.e., no glycerol additive).

DISCUSSION

The results from this study suggest that freezing clinical mastitis milk samples will have a different impact depending on the pathogenic agent. Gram-positive bacteria were unaffected by freezing at either temperature of duration, likely due to the additional protection provided by the cell wall. Gram-negative bacteria were negatively impacted by freezing for longer than 1 week and at -80°C. Yeasts also were not culturable after any freezing, indicating that culturing after period of freezing could lead to significant findings being missed. Given that a farmer will not know the type of pathogen causing the mastitis on farm prior to culture, this study would suggest that sending samples for culture fresh will provide the most accurate results.

The ability of glycerol to act as a cryopreservant is so far inconclusive due to it currently only being tested on Gram-positive bacteria. This trial will be expanded to include a greater number of samples and will investigate the impact of glycerol on Gram-negative pathogens. Future samples will also be subjected to freezing for 3- and 6-months to assess if Gram-positive bacteria will display a decrease in culturability at these extended durations.

CONCLUSIONS

Mastitis samples should be sent fresh for culture to ensure the most accurate results. Future work will expand this trial to include greater sample numbers and extended freezer storage durations of three and six months. Assessment of the effects of using glycerol as a cryopreservant was inconclusive and will be explored further.

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ACKNOWLEDGEMENTS

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TRENDS IN DAIRY HERD ANTIMICROBIAL USAGE: FROM THE LOWEST USERS TO THE HIGHEST

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SUMMARY

Reductions in antimicrobial usage (AMU) are being seen across the board in dairy herds using Kingshay's antimicrobial monitoring service, with mean AMU at 13.7mg/kg PCU in 2023, compared to 15.9mg/kg PCU in 2022. When herds are ranked by their usage and then split into quartiles, all four quartiles saw a reduction in mean AMU compared to the previous year. However, individual farm usage can vary hugely from year to year, with 49% of herds changing quartiles compared to the previous year. This shows the continued need for focus on responsible use irrespective of a herd's previous usage patterns.

INTRODUCTION

There is continued focus on responsible antimicrobial usage in the dairy industry. The industry needs information to interpret the AMU data that is being collected, and benchmarks to guide how much individual farms can be expected to change.

Kingshay's antimicrobial monitoring service was established in 2017 in response to demand from farmers, vets, and milk processors. The results are published annually in our Dairy Antimicrobial Focus Report, which is free to download at www.kingshay.com.

METHODOLOGY

We obtained client sales data from the vet practice for each herd, with livestock numbers and other herd details gathered from the farmer. The report was then validated by both the vet and the farmer to ensure its accuracy. Other enterprises (such as beef and sheep units) where antimicrobial sales were on the same account were removed, and adjustments were made for products bought in bulk and not used in the specified time period. The number of herds where such data was gathered for both 2022 and 2023 was 858.

RESULTS

Herd AMU ranged from 0.04 to 124.9mg/kg PCU. The median herd AMU was 11.3mg/kg PCU, the mean was 13.7 mg/kg PCU (for the year ending March 2023), down from the mean in 2022 which was 15.9mg/kg PCU.

Figure 1. Antimicrobial use trends over 5 years

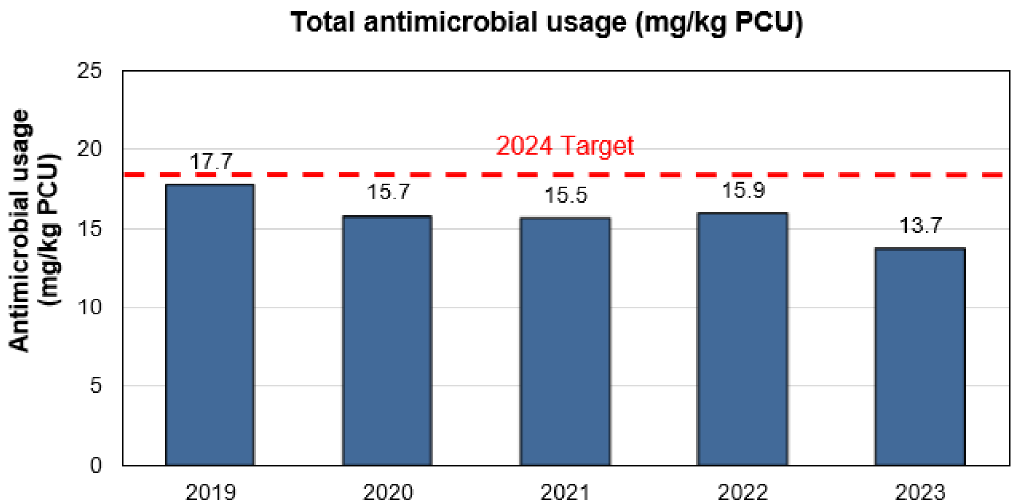

Figure 2 shows data points from individual herds, ranked by their AMU in 2023. Both their total AMU is shown (blue bars) and their individual change from the previous year (green bars). This graph is sectioned into quartiles. Within each quartile there are herds that have made big changes from the previous year. In fact, 49% of herds were in a different AMU quartile to the previous year. Not only has the mean of AMU for the herds decreased from 15.9mg/kg PCU in 2022 to 13.7mg/kg PCU in 2023, the mean AMU within every quartile has decreased compared to the same quartiles last year, as seen in Table 1.

Figure 2. Range of antimicrobial use by individual dairy herds

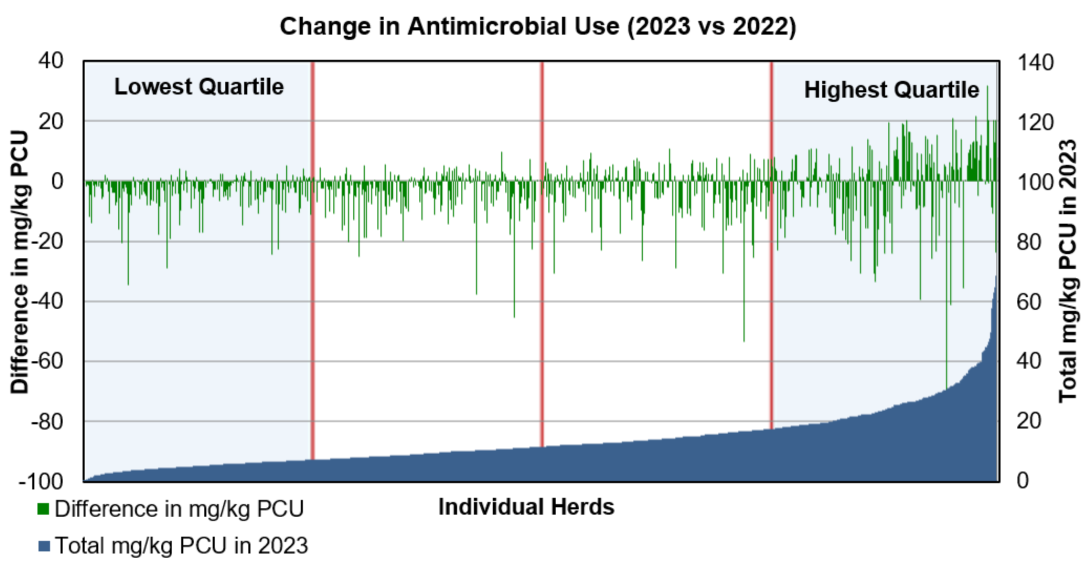

Table 1. Quartile analysis of antimicrobial usage

Antimicrobial Use by Quartile (mg/kg PCU)	Lowest 25%	2nd 25%	3rd 25%	Highest 25%
Total injectables (mg/kg PCU)	3.26	6.75	10.57	18.80
Critically important injectables (mg/kg PCU)	0.007	0.010	0.010	0.023
Dry cow tubes (DCDVet)	0.318	0.415	0.516	0.530
Lactating cow tubes (DCDVet)	0.267	0.362	0.441	0.641
Sealant tube usage (courses/cow)	0.379	0.60	0.41	0.48
DDDVet	1.23	1.97	2.69	4.27
DCDVet	0.63	0.97	1.30	1.78
Total antimicrobial usage (mg/kg PCU)	**4.7**	**9.2**	**14.1**	**26.7**
Change on last year (mg/kg PCU)	**-0.7**	**-1.4**	**-2.2**	**-4.6**

CONCLUSIONS

The industry has achieved good reductions in AMU across the board. It can be tempting to pigeonhole herds as “low antimicrobial users” or “high antimicrobial users”, and link usage to demographics, but the data shows the AMU of a herd in any quartile can change hugely year-on-year. Seen in the light of other analyses in the Kingshay Dairy Antimicrobial Focus Report, there is no strong relationship between AMU and herd size (r^2=0.0116) or milk yield per cow (r^2=0.079). This means it is essential that herds maintain their focus on responsible usage in the face of changing farm conditions and disease challenges.

The 25% of herds with the highest AMU are skewing the data and contributing a disproportionate amount to the overall usage of the group. Benchmarking to a large pool of herds is essential, particularly when interpreting data from a small number of herds, where between-herd differences and within-herd year-on-year differences can vary to large degrees.

Proceedings of the British Mastitis Conference (2024) Sixways, Worcester, p 80 - 81
The Dairy Group, The University of Nottingham, BCVA & QMMS

E.COLI AND *PSEUDOMONAS AERUGINOSA:* MICROBIOLOGICAL TESTING OF OXI-TECH SOLUTIONS' PULSE OXIDATION CELL OZONE SYSTEM

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SUMMARY

Micro-biological experiments undertaken using a single concentration of ozone (1-2ppm) and using *E. coli* and *Pseudomonas aeruginosa* clearly showed that treated water which had flowed at a rate of between 2 and 3 litres per minute through the Oxi-Tech Solutions' *Pulse Oxidation Cell* ozone system was highly efficient at killing these bacteria.

INTRODUCTION

A series of tests were undertaken to assess how efficiently water treated using the Oxi-Tech Solutions' *Pulse Oxidation Cell* ozone system would prevent various representative types of bacteria replicating on suitable nutrient agar plates.

MATERIALS AND METHOD

Oxi-Tech Solutions' *Pulse Oxidation Cell* ozone system was integrated into the laboratory water supply, with the addition of an inline carbon filter prior to the device, to remove the chlorine from the water in order, to prevent it from killing the bacteria in the subsequent microbiological tests. The water was treated in a single pass through the device and then drained away - for samples to be collected whenever required for the experiment - the water was not recirculated through the device.

A flow rate of between 2 and 3 litres per minute was chosen for this test, for which the unit was expected to deliver ~2ppm ozone (in use concentration estimated at 1ppm), stable in use concentrations when measured were in the region of 1-2ppm.

The experiment was repeated for various types of bacteria including *E. coli* and *Pseudomonas aeruginosa*. The bacterial spike in each case was mixed with water that had been freshly treated by the prototype ozone device and also with water that had passed through the carbon filter and through the device, but before the device had been switched on.

For each experiment, 4ml of a stock solution containing the bacteria under investigation was added to a plastic centrifuge tube. Then 10ml of the water (either with or without ozone) was added to the tube, the mixture agitated to mix it thoroughly but very quickly, then 0.5ml of the mixture was quickly drawn off using a 0.5ml pipette with a clean tip each time. This liquid was then spread onto the standard nutrient Agar plate used for the particular bacteria of interest using a fresh, disposable spreader each time. The nutrient plates were then incubated appropriately, and a bacterial colony count was performed – all following the approved procedures for Mercian's UKAS accredited laboratory.

To estimate the number of viable bacteria that were being mixed into the water samples (both ozone treated and without ozone), a 0.5ml sample of each of the stock solutions at the beginning of each measurement run was also spread onto the standard nutrient Agar plate used for the particular bacteria of interest.

RESULTS AND CONCLUSIONS

E. coli: When exposed to the water containing no chlorine and no ozone, the bacterial counts on the plate were unaffected by contact time, as expected. The colony count was approximately 100 CFU/half- millilitre, again as expected. Findings from the three 'ozone' tests demonstrated the bacteria were killed immediately by the presence of the ozone in all cases confirming Oxi-Tech Solutions' *Pulse Oxidation Cell* ozone system is highly efficient in killing E. coli bacteria in a flowing water pipe.

Pseudomonas aeruginosa: The concentration of the bacteria's spike was measured as 74CFU/half ml. This was then diluted by the addition of the water such that the concentration in the samples would be expected to be ~21CFU/ml. The results using non-ionised water correlate with these predicted values.

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Proceedings of the British Mastitis Conference (2024) Sixways, Worcester, p 82 - 84
The Dairy Group, The University of Nottingham, BCVA & QMMS

TESTING OXI-TECH SOLUTIONS PULSE OXIDATION CELL OZONE SYSTEM'S IMPACT ON A *PSEUDOMONAS AERUGINOSA* BIOFILM

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SUMMARY

Ozone produced by Oxi-Tech's *Pulse Oxidation Cell* is highly efficient at clearing a *Pseudomonas aeruginosa* biofilm in a relatively short time, provided that the ozone concentration exceeds a certain level for a certain amount of time. This experiment showed that raising the ozone concentration to >0.4ppm for 90 minutes, followed by a sustained lower level dose of approximately 0.2 ppm was sufficient to completely clear the biofilm from the system. A higher dose of ozone for a shorter time might achieve the same effect.

INTRODUCTION

A series of tests were undertaken to deliberately grow a *Pseudomonas aeruginosa* biofilm within a recirculating water system, detect the presence of the biofilm with the SOLxi-TEK biofilm monitor and then determine the effectiveness of the Oxi-Tech Solutions' *Pulse Oxidation Cell* ozone system at biofilm removal.

MATERIALS AND METHOD

Tap water was passed from a tank through a carbon filter to remove chlorine and subsequently pumped through the SOL Oxi-TEK biofilm monitor and then on through the Oxi-Tech Solutions' Pulse Oxidation Cell ozone system and then back into the tank.

The tank water in the tank was spiked with a concentration of *Pseudomonas aeruginosa* bacteria of >10,000 CFU/ml and once a thick biofilm layer had grown within the system, the Pulse Oxidation Cell was switched on to generate ozone in the recirculated water measuring 24°C.

The ozone concentration of the water in the tank rose slowly rose steadily from zero to approximately 0.15ppm over a period of 4 hours and maintained at that level for a further 2 hours. Over the entire period covered by the plot, the total viable count as a measure of the planktonic *Pseudomonas aeruginosa* bacteria suspended in the water fell from >100,000 CFU/ml to approximately 20,000 CFU/ml, a factor 5 reduction.

The ozone concentration was then stepped up to >0.4ppm resulting in the average total viable count (TVC) count falling to an average of 63 CFU/ml; a factor 38 reduction.

The experiment next featured a 'shock' dose of ozone of >0.4ppm for 90 minutes, followed by a sustained lower level dose of approximately 0.2 ppm, was sufficient to completely clear the *Pseudomonas aeruginosa* biofilm from the system over a period of 20 hours.

Furthermore, once all of the *Pseudomonas aeruginosa* biofilm had been eradicated, the TVC level fell to an average of just 1.5 CFU/ml. This suggests that the ozone was highly efficient in destroying planktonic bacteria in the first instance, and in turn it reduced the planktonic bacteria to effectively zero.

RESULTS AND CONCLUSIONS

The *Pulse Oxidation Cell* produces ozone in such a way that is highly efficient at clearing *Pseudomonas aeruginosa* biofilm in a relatively short time, provided that the ozone concentration exceeds a certain level for a certain amount of time. This experiment showed that raising the ozone concentration to >0.4ppm for 90 minutes, followed by a sustained lower level dose of approximately 0.2 ppm was sufficient to completely clear the *Pseudomonas aeruginosa* biofilm from the system. It is also possible that a higher dose of ozone for a shorter time might achieve the same effect.

REFERENCES

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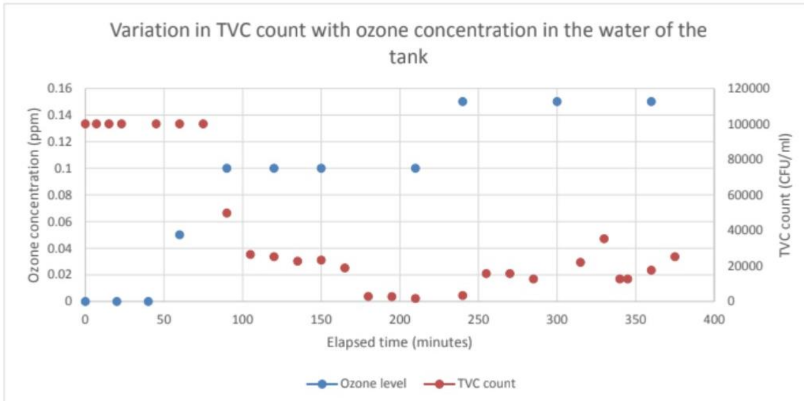
Figure 1. Plot of Ozone Concentration in ppm and Total Viable Count in CFU/ml vs elapsed time



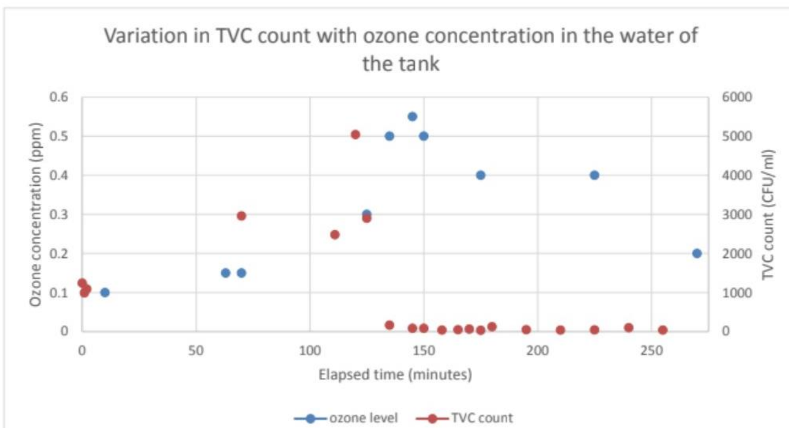


Figure 2. Biofilm observed on monitor at start:

0 hours ***10hrs*** ***20hrs***

Proceedings of the British Mastitis Conference (2024) Sixways, Worcester, p 85 - 86
The Dairy Group, The University of Nottingham, BCVA & QMMS

MEASURING THE IMPACT OF KEY UDDER HEALTH PARAMETERS ON DRY PERIOD CURE RATE

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With the recent updates to the Veterinary Medicines Regulations, there is growing pressure on UK farmers to reduce unnecessary use of antimicrobials. Part of the legislation on prophylactic use essentially bans the use of blanket antibiotic dry cow therapy (BDCT) in UK dairies. This means that any dairy farms that are not carrying out selective dry cow therapy will be required to do so.

As farmers move away from BDCT towards a selective approach, it is important to monitor clinical mastitis and somatic cell count data. A key metric is dry period cure rate (DPCR), defined as the proportion of the herd with a high cell count prior to drying off, that calve in with a low cell count at the first milk recording of the next lactation. Appropriate dry cow therapy is important in maximising DPCR, but other herd factors may also be influential. This study aims to identify herd-level parameters that may have an impact on dry period cure.

Data were collated from a convenience sample of 350 herds. Udder health metrics were calculated on an annual basis on the 31/12/2023, using TotalVet. Twenty-three farms with an improbable dry period cure or new infection rate (0% or 100%) were excluded. Key udder health statistics are summarised for these 327 herds in Table 1. A linear regression model was created to identify variables that influence dry period cure rate, and quantify their effect size. The results of the model are presented in Table 2.

Table 1: Summary of udder health statistics across 327 herds

	Median	**Mean**	**Range**	**Interquartile range**
Dry period cure rate	79.6	77.6	46.2 – 84.4	70.5 – 84.8
Dry period new infection rate	14.7	15.1	5.0 – 36.8	11.1 – 18.3
Lactation new infection rate	6.5	6.8	2.2 – 23.3	5.0 – 8.0
Calculated average bulk milk Somatic Cell Count	162	174	71– 630	138 – 203
Herd size	219	282	60 – 1771	150 – 325

Table 2: Model output – predicting Dry Period Cure Rate

	Estimate	**P value**
Intercept	89.90	<0.001
Calculated Average BMSCC	-0.068	<0.001
Dry Period New Infection Rate	-0.35	0.0017
Lactation New Infection Rate	0.48	0.12
Herd Size	0.0051	0.046

The most significant drivers of DPCR were bulk somatic cell count and Dry Period New Infection Rate (DPNIR). Hypothetically, reducing average bulk milk SCC by 50,000 cells/ml could improve DPCR by 3.4 percentage points. For every 1 percentage point decrease in DPNIR, the DPCR was improved by around a third of a percent. Larger herds had a numerically better DPCR, though the impact is of limited clinical importance. For example, herds milking 200 cows, could expect to have a 0.5% higher DPCR than herds milking 100.

Lactation new infection rate was not significantly associated with DPCR. This is consistent with previous research which shows that risk factors for infections are different during the dry period and lactation.
A herd-level approach to selective dry cow therapy, should consider the target cure rate, as well as the bulk SCC. In order to maximise perceived cure, farmers should focus on preventing new infections, alongside the use of appropriate dry cow therapy.

NOTES