BRITISH MASTITIS CONFERENCE

2020

Organised by

The Dairy Group

British Cattle Veterinary Association

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

QMMS

Topics:

- Update on dry cow therapy
- Minor & major mastitis organism update
- Research updates
- Ensuring change happens on farm
- Mastitis control on AMS farms
- Applying AHDB Dairy QuarterPro

Wednesday 11th November 2020

Virtual Conference

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GENERAL INFORMATION

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CHAIRMAN'S INTRODUCTION

Welcome to the 2020 Virtual British Mastitis Conference.

The Organising Committee has worked hard since last year's conference to bring together a group of speakers, both international and home grown, that we believe will prove thought provoking and stimulating presentations. We have strived to balance the latest research with practical presentations and clear take home messages.

Our first paper will provide an update on dry cow therapy, which will be followed by a paper on the latest information on minor and major mastitis pathogens. There will then be a short "refreshment and comfort" break

Building on the previous success, endorsed by delegates in 2019, we have selected four posters from the Knowledge Transfer section for oral presentation. The four papers are followed by an opportunity for delegates to debate with the presenters.

After lunch we investigate how to inspire and support change on farm and ensuring it happens. The penultimate paper is on mastitis control on AMS farms, and there is a slight change to the format of the final paper at BMC. The presentation will be an overview on the application of AHDB Dairy QuarterPRO for mastitis control**.**

Although BMC 2020 is a Virtual conference, we have continued with the Poster section. You can review the posters submitted at the back of the Proceedings and we will again hold the Best Poster Competition. Many of you know that the presenters put a great deal of effort into providing the abstracts and preparing and presenting their posters. So please do read their work and vote.

We endeavour to find you the best speakers with the most relevant (and latest) information. This is only achievable thanks to all our generous sponsors – all who have supported our move to a virtual format for 2020. This year our sponsors are: Vetoquinol (Platinum), Hipra (Gold), MSD Animal Health (Gold), milkrite | InterPuls (Silver), Boerhinger Ingelheim (Silver), Norbrook (Silver), Zinpro (Silver), Ambic (Bronze) and DeLaval (Bronze).

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 logging-in to and supporting the conference. I trust you will have an enjoyable and worthwhile day and we hope to "physically" see you at our 33rd BMC in 2021.

Ian Ohnstad, British Mastitis Conference Chairperson
The Dairy Group

TIMETABLE of EVENTS

09:30	**LOG-ON OPENS**	
09:45	**CHAIRMAN'S INTRODUCTION**	**Ian Ohnstad** *The* Dairy Group, UK
	Session One	
09:55	Selective dry cow therapy at the quarter level – an update.	**Andrew Bradley** University of Nottingham, UK
10:30	An update on minor and major mastitis pathogens.	**Sarne De Vliegher** Ghent University, Belgium
11:05	**COFFEE and POSTERS**	
	Research updates (also presented as posters)	
11:40	Dynamic vacuum control strategies and review of ISO guidelines for milking vacuum.	**Doug J Reinemann.** University of Wisconsin, USA
12.00	Applying internal teat sealants at drying off; does full versus partial insertion of the tube cannula matter?	**Georgios Oikonomou** University of Liverpool, UK
12:20	Field evaluation of the efficacy of intramuscular injections of penethamate (Permacyl®) for the treatment of clinical mastitis in lactating dairy cows in association or not with an intramammary suspension of cefalexin+kanamycin (Ubrolexin®).	**Erik Grandemange** Vetoquinol, France
12:40	High somatic cell counts are not always a consequence of intramammary infections: A review.	**Huw McConochie** Zinpro, The Netherlands
13:00	**LUNCH and POSTERS**	
14:10	**WELCOME BACK AND VOTING ON POSTERS**	
	Session Three	
14.15	Inspiring and supporting change on farm. Making it happen!	**Lisa Morgans** Innovation for Agriculture, UK
14.50	Mastitis control in Automatic Milking Systems.	**Tom Greenham** Advance Milking, UK
15.25	Using the 'QuarterPRO' mastitis control scheme in practice: overview and herd examples.	**James Breen** University of Nottingham, UK
16:00	**POSTER AWARD**	
16:05	**CLOSE**	

Titles of Papers and Presenters

Scientific programme

Titles of Posters and Authors

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

Titles of Posters and Authors - continued

APPENDIX

POSTERS SUBMITTED (prior to print)

Erik Grandemange *et al.*

Huw McConochie & Alturo Gomez

Katharine *et al.*

James Breen *et al.*

Georgios Oikonomou *et al.*

Andrew Bradley *et al.*

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

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

What does NMC do?

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

Who are the members of NMC?

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

What can NMC do for you?

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

Why join NMC?

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

NMC membership benefits

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

Working together

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

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Proceedings of the British Mastitis Conference (2020) Sixways, Worcester, p 1 - 10
The Dairy Group, The University of Nottingham, QMMS and BCVA

SELECTIVE DRY COW THERAPY AT THE QUARTER LEVEL - AN UPDATE

A.J. Bradley[1,2], K.A. Leach[1], J.E. Breen[2], B. Payne[1], V. White[1], M.J. Green[2] and J. Swinkels[3]
[1] Quality Milk Management Services Ltd., Cedar Barn, Easton Hill, Easton, Wells, Somerset, BA5 1DU, UK,[2] School of Veterinary Medicine and Science, University of Nottingham, Sutton Bonington Campus, Sutton Bonington, LE12 5RD, UK; [3] MSD Animal Health, P.O. Box 31, 5830 AA Boxmeer, The Netherlands. E-mail: andrew.bradley@qmms.co.uk

SUMMARY

The importance of the dry period in mastitis epidemiology and the roles of antibiotic dry cow therapy and internal teat sealants are well established. Continued pressure on the use of antimicrobials in food producing animals, and prophylactic use in particular, means that the use of antibiotic dry cow therapy remains a focus of the industry. Whilst the selective use of antibiotic dry cow therapy at the cow level is well established, the selective use at quarter level is less well understood. This paper outlines the findings of a large UK study investigating selection of antibiotic treatment at the quarter level in both low and high SCC cows at drying off using the California Mastitis Test (based on its widespread availability and low cost). Analysis of data from this study suggests that in herds with a low SCC and low prevalence of contagious pathogens there is no justification for the general use of supplementary antibiotics in CMT positive quarters in low SCC cows at drying off. However, there may be scope to further reduce antibiotic use by withdrawing antibiotics from low SCC (CMT negative) quarters in high SCC cows. Any such approach should be implemented with care and only when a mechanism for monitoring the likely impact is in place.

INTRODUCTION

The importance of the dry period in mastitis epidemiology is well acknowledged (3) as are the benefits of the use of antibiotic dry cow therapy. The selective use of antibiotic dry cow therapy in combination with blanket use of an internal sealant has been advocated for a number of years and is well supported in the scientific literature (6,9) and by UK based research (2, 4,5,10). Concern around the prophylactic use of antibiotics has resulted in questions being raised about the use of antibiotics in quarters not infected at drying off, primarily from the perspective of reducing antibiotic use (11). Historically, cow level application of antibiotic dry cow therapy has been advocated, primarily because quarters are not independent within cows and therefore an increased risk of infection has been perceived in 'uninfected' quarters in 'infected' cows (1). However, there is evidence that this lack of independence is less marked with 'environmental' than 'contagious' mastitis pathogens. There has also been concern that the 'cow level' approach will result in some infected quarters not being treated and therefore being at increased risk of being infected at calving. Ultimately, a quarter level selective dry cow treatment approach may potentially further reduce the use of antibiotics when compared to selective dry cow treatment at the cow level and could result in better overall dry period outcomes. However, whilst growing, to date, peer-reviewed data on the outcome of dry period treatments allocated at quarter level is very limited. In an Australian study (7) restricted to cows infected at drying off, which suggested increased new infections following quarter level treatment of cows infected at drying off, the effect was dominated by *S. uberis* and *S. aureus*. These findings, and those of a following study (8), may not be transferable to herds with low somatic cell count, therefore further data is needed to inform the UK situation. This paper reports results from the first large study to investigate the outcome of quarter level dry cow treatments in low SCC herds, with low levels of contagious mastitis, in the UK.

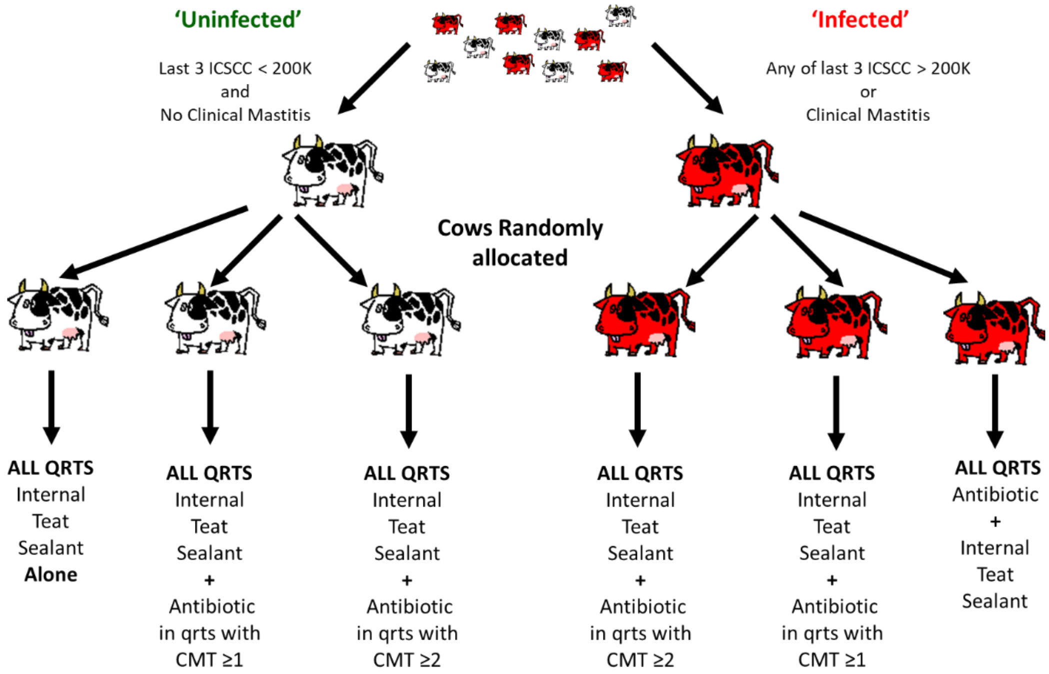
MATERIALS AND METHODS

Commercial farms in the south-west of England were selected to participate on the basis of 1) likely compliance with the study protocol, 2) a bulk milk somatic cell count typically less than 200,000 cells/ml 3) monthly individual cow somatic cell count testing and 4) retrospective records of clinical mastitis for at least 12 months.

Cows, within herds, were stratified ('infected' or 'uninfected') using somatic cell count and clinical mastitis history, before being randomly allocated to one of three treatment groups: SCLT, SQLT1 and SQLT2. The SCLT (Cow Level Treatment) group were allocated, using somatic cell count and clinical mastitis history, into animals eligible for the use of an internal teat sealant alone (Cepralock™) or an internal teat sealant in combination with antibiotic dry cow therapy (CEFA-SAFE™) - importantly this decision was applied at the cow level with all quarters within a cow receiving the same treatment. Within the SQLT1 (Quarter Level Treatment - CMT≥1) and SQLT2 (Quarter Level Treatment - CMT≥2) groups, quarters within cows were allocated (based on a CMT score of ≥1 or ≥2 respectively) to receive an internal teat sealant alone (score below the threshold) or an internal teat sealant in combination with antibiotic dry cow therapy (score above or equal to the threshold) depending on the quarter California Mastitis Test (CMT) score at drying off. The overall design is illustrated in Figure 1 overleaf. The quarter was the experimental unit. It was anticipated that approximately 250 cows would be recruited to each treatment group (750 cows, 3,000 quarters in total). Cows were recruited over a 12-month period to allow seasonal effects to be investigated.

At Drying Off: Cows were recruited prior to their final milking in lactation, assessed for suitability for enrollment and randomly allocated to one of the three treatment groups. All quarters of all cows were subjected to the CMT, prior to being aseptically sampled. Samples for bacteriology and somatic cell count analysis were collected from each quarter. Data on parity, yield at drying off, historic somatic cell count data, clinical mastitis history, treatment history and other relevant clinical data were collated. Samples were maintained at or below 8°C whilst transported to the laboratory for analysis. Treatments were administered, following strict asepsis and according to datasheet recommendation.

Figure 1 An illustration of the study design



At Calving: Within one week of calving, samples for bacteriology and SCC were collected from each quarter and a CMT test carried out on each quarter.

Post Calving: Between 7 and 14 days post calving, a CMT test was performed on each quarter and quarter milk samples were collected for SCC determination.

After Calving until 100 Days Post-Calving: Cows were managed according to normal husbandry practices on the farm. Any disease or concurrent treatments were recorded. Any cases of clinical mastitis were scored for severity and recorded by trained farm staff. Clinical samples were frozen before transport in batches to the laboratory.

Laboratory Methods

Microbiological investigation and Somatic Cell Counts were carried out in accordance with the methods recommended by the International Dairy Federation (IDF) (Bulletin No 132, 1981), International standard 13366-1: 1997 (E) and 13366-2: 1997 (G). In summary, samples were inoculated onto blood, MacConkey, and Edwards agar and incubated for 72 hours at 37°C. Both the blood and Edwards agar were inoculated with 10µl of milk. The MacConkey agar was inoculated with 100µl of milk to enhance the chances of isolation of *Enterobacteriaceae* and *Staphylococcus* spp. All organisms were identified and enumerated. Organisms were identified primarily by using

MALDI-TOF MS, but also where necessary on the basis of typical colony morphology, gram staining, and further biochemical tests.

Assessment of Effectiveness

Four primary outcomes were assessed as outlined below:

Outcome 1: Cure of Existing IMIs.
Bacteriological Cure: The overall, and species specific, cure rates were estimated and compared between groups. A cure was defined as the absence of a pathogen in the post calving sample that was present at drying off.
SCC Cure: Cure rates were also estimated and compared between groups, at both the cow and quarter level, by investigating SCC movements around pre-defined thresholds.
Outcome 2: Acquisition of New IMIs.
Bacteriological New IMI: The overall, and species specific, new infection rates were estimated and compared between groups. A new infection was defined as the presence of a pathogen in the post calving sample that was not present at drying off.
Outcome 3: A Successful Dry Period Outcome.
Successful dry period outcomes were estimated and compared between groups. A successful outcome was defined in two ways; firstly, as the absence of a major pathogen from the post calving sample and secondly as the absence of any mastitis pathogen from the post calving sample.
Outcome 4: Prevention of Clinical Mastitis in the 1st 100 Days of the Subsequent Lactation.
The overall, and species specific, incidence rate of clinical mastitis were assessed in the first 100 days of lactation and compared between groups.

Further analyses were also undertaken to better understand the utility of the CMT test as an approach to selecting cows for treatment with antibiotic and the impact of the different selection strategies on antibiotic use.

Statistical Analysis

Power and Sample Size: Calculations based on UK data suggested that assuming 80% power and 95% confidence in a two-sided test the sample sizes allow detection of a 6% (absolute) difference in a successful dry period outcome, given a baseline level of 70% of quarters being pathogen free post calving in the CLT group.

Data were collated and initially analysed using Excel and Access (Microsoft Corp) and Minitab (Minitab Inc). Descriptive and graphical analyses were carried out to explore the data. Univariable analysis of treatment efficacy was performed using the Chi-Square test to investigate differences in proportions between groups. Analysis was undertaken assessing 'infected' and 'uninfected' cows both separately and together. Multilevel logistic regression models were specified to investigate treatment outcomes.

RESULTS

A total of 807 cows were recruited from six herds. Data was available for analysis from 764 cows, 381 defined as 'infected' and 383 defined as 'uninfected' at drying off by historic SCC and clinical mastitis data. Key characteristics of the study farms are summarised in Table 1, and of cows available for analysis in Table 2.

Table 1 Key characteristics of the study farms

	Farm					
Variable	**C**	**F**	**H**	**M**	**R**	**T**
Herd size - Number of cows in milk	730	225	249	150	223	580
Number of cows enrolled	250	93	113	46	100	205
12 mo Geometric mean BMSCC$	122	171	146	155	237	313
CM incidence in 12 mo prior to study start*	20	34	74	42	77	23
305 d Milk Yield (l) at study start	10,115	9,975	8,790	7,633	7,716	10,878
Dry cow winter housing	C,Y	C,Y	Y	C,Y	C,Y	C,Y
Dry cow summer housing	P	C,Y	P	P	P	Y
Dry cow bedding	Sand	Sand	Straw	Straw	Straw	Straw
Milking frequency/day	3X	2X	2X	2X	2X	3X

$ Calculated bulk milk SCC based on individual cow recording
* Cases/100 cows/year
C = Cubicles, Y = Yards, P = Pasture

Table 2 Key characteristics of cows in each of the study groups

Infection Status at Dry Off	**Infected**			**Uninfected**		
Treatment Group	**SCLT**	**SQLT1**	**SQLT2**	**SCLT**	**SQLT1**	**SQLT2**
n	126	122	133	125	128	130
Parity (Mean)	2.55	2.60	2.48	2.00	2.11	2.18
Yield (l) (Mean)	16.4	16.8	17.0	18.7	17.7	18.3
SCC-1 (Median)	247	262	279	59	66	62
SCC-2 (Median)	204	196	204	48	54	51
SCC-3 (Median)	183	169	176	44	48	39
Dry Period Length (d)	57.8	54.0	57.2	54.5	53.5	53.4

(SCCs in the 3 months prior to drying off (,000 cells/ml))

The results of CMT tests conducted at drying off are summarised in Table 3, by infection status and treatment group. As might be expected, CMT scores were higher in the 'infected' category, with approximately 70% of quarters exhibiting at least a 'trace' reaction to the CMT, whilst approximately 70% of quarters in the 'uninfected' category demonstrated no reaction to the CMT.

Table 3 Percentage of quarters with each CMT score at drying off, by treatment group

Infection Status at Dry Off	**Infected**			**Uninfected**		
Treatment Group	**SCLT**	**SQLT1**	**SQLT2**	**SCLT**	**SQLT1**	**SQLT2**
n	504	488	504	504	516	524
Score 0	30.8	30.5	35.7	71.6	69.2	68.3
Score 1	27.6	26.0	18.8	19.6	21.1	19.3
Score 2	29.4	26.8	32.1	7.3	7.6	10.9
Score 3	12.3	16.6	13.4	1.4	2.1	1.6

Note: Columns may not sum to 100 due to rounding

The prevalence of 'infection' at dry off for some of the key mastitis pathogens is summarised in Table 4. The overall prevalence was low with only 10.5% of quarters culturing a major pathogen. Minor pathogens were the most common finding with 52.8% of quarters culturing positive for one or more minor mastitis pathogens.

Table 4 Summary of key bacteriological findings in quarters at drying off.

Cow Level 'Infection' Status at Dry Off *	**Overall (n = 3,056)**		**Infected (n =1,524)**		**Uninfected (n=1,532)**	
Pathogen	n	%	n	%	n	%
Staphylococcus aureus	26	0.85	17	1.12	9	0.59
Streptococcus uberis	21	0.69	19	1.25	2	0.13
Streptococcus dysgalactiae	6	0.20	6	0.39	0	0.00
Escherichia coli	12	0.39	7	0.46	5	0.33
Enterobacteriaceae	17	0.56	10	0.66	7	0.46
***Yeast* spp**	21	0.69	12	0.79	9	0.59
All Major Pathogens	322	10.5	200	13.1	122	7.96
Major Gram-positive Pathogens	241	7.89	158	10.4	83	5.42
Major Gram-negative Pathogens	76	2.49	38	2.49	38	2.48
Minor Pathogens	1,612	52.8	883	57.9	729	47.6
No Growth	1,289	42.2	543	35.6	746	48.7

* as defined by historic SCC and clinical mastitis data

The prevalence of 'infection' at calving for some of the key mastitis pathogens is summarised in Table 5. The overall prevalence was low with only 12.0% of quarters culturing a major pathogen. Minor pathogens were the most common finding with 33.3% of quarters culturing positive for one or more minor mastitis pathogens. More quarters were free of any pathogen post calving than prior to drying off, though this difference was 'driven' by control of minor mastitis pathogens.

Table 5 Summary of key bacteriological findings in quarters at calving

Cow Level 'Infection' Status at Dry Off *	Overall (n = 3,056)		Infected (n =1,524)		Uninfected (n=1,532)	
Pathogen	**n**	**%**	**n**	**%**	**n**	**%**
Staphylococcus aureus	10	0.33	6	0.39	4	0.26
Streptococcus uberis	50	1.64	24	1.57	26	1.70
Streptococcus dysgalactiae	9	0.29	5	0.33	4	0.26
Escherichia coli	20	0.65	6	0.39	14	0.91
Enterobacteriaceae	43	1.41	19	1.25	24	1.57
***Yeast* spp**	35	1.15	23	1.51	12	0.78
All Major Pathogens	367	12.0	206	13.5	161	10.5
Major Gram-positive Pathogens	230	7.53	130	8.53	100	6.53
Major Gram-negative Pathogens	121	3.96	63	4.13	58	3.79
Minor Pathogens	1,016	33.3	449	29.5	567	37.0
No Growth	1,608	52.6	848	55.6	760	49.6

* as defined by historic SCC and clinical mastitis data

Multilevel logistic regression models were specified to investigate the likelihood of a quarter being free of a major pathogen or free of a minor mastitis pathogen in the 'infected' and 'uninfected' cow categories. No differences between treatment groups, within either infection category, were identified with respect to the likelihood of being infected with a major pathogen post calving.

No differences were identified between treatment groups in the likelihood of being infected with a minor pathogen post calving in the 'infected' cow category. However, in the 'uninfected' cow category, when compared to the SCLT group, quarters in the SQLT1 group were at significantly decreased odds of being infected with a minor pathogen (OR 0.66; 95% CI 0.49 to 0.89), whilst the SQLT2 group did not differ (OR 0.76; 95% CI 0.57 to 1.02).

When considering clinical mastitis in the first 100 days of lactation, no significant differences were identified between any of the treatment groups within infection category.

The impact of treatment on somatic cell count at the first test day after calving was investigated and is summarised in Table 6. Whilst not evident in the univariable analysis, multivariable analysis revealed that in the infected cow category, compared to cows in the SCLT group (received AB in all quarters), SCCs were significantly higher at the 1st test day in cows the SQLT2 group (only receiving AB in quarters with a CMT ≥2). In the uninfected cow category compared to the SCLT group (receiving no AB), SCCs were significantly lower in the SQLT1 group receiving AB in quarters with a CMT ≥1).

Table 6 Summary of individual cow lnSCCs at the first dairy herd improvement test day in lactation in different treatment groups within the different infection categories at drying off

Treatment Group	n	Mean	SE Mean	StDev	Minimum	Maximum
Infected Cow Category at Drying Off						
SCLT	126	3.93	0.13	1.45	1.39	7.90
SQLT1	113	3.91	0.14	1.46	1.39	7.76
SQLT2	127	4.13	0.14	1.56	1.61	8.79
Uninfected Cow Category at Drying Off						
SQLT1[b,c]	124	3.75	0.12	1.33	0.69	8.82
SQLT2[a,c]	127	4.00	0.13	1.50	1.10	8.46
SCLT[a]	122	4.23	0.14	1.58	1.39	8.84

[a,b] superscripts within column, within infection category differ.

Antibiotic use was assessed in each of the treatment groups with respect to the number of cures effected by treatment. In the cows defined as 'infected' at drying off, significantly less antibiotic tubes were used per cure in the SQLT2 and SQLT1 treatment groups than in the SCLT group (3.87 vs 10.12; P < 0.001 and 5.06 vs 10.12; P < 0.001 respectively), but the number of tubes used per cure did not differ between the quarter level treatment groups; the apparent cure rate did not differ between treatment groups. In cows defined as uninfected at drying off, significantly more antibiotic tubes were used per cure in the SQLT1 and SQLT2 treatment groups than in the SCLT group (3.24 vs 0.00; P < 0.001 and 2.03 vs 0.00; P < 0.001 respectively); the number of tubes used per cure also differed between the SQLT1 and SQLT2 quarter level treatment groups (3.24 vs 2.03; P = 0.009); the apparent cure rate did not differ between treatment groups and the only infections which did not cure were caused by Enterobacterial and *Yeast* spp against which the antibiotic DCT would not have been effective

DISCUSSION AND CONCLUSIONS

This study is the first large scale investigation into the selection of dry cow therapy at the quarter level in the UK. Historically, such approaches have not been favoured on the basis of the lack of independence of quarters within cows, meaning that it was considered that the risk of missing a major pathogen infection in another quarter of a high cell count cow was too high. For this reason, this study focussed on relatively low SCC herds likely to reflect the general population of herds currently in the UK.

The prevalence of infection at dry off in this study was low, with classic contagious pathogens such as *S. aureus* representing less than 10% of all major pathogen infections; less than 1% of quarters were apparently infected with this pathogen at drying off. The aetiology in these herds is clearly 'environmental' and minor pathogens represented the vast majority of infections present at drying off. Cure rates and apparent 'self-cure' rates in this study were very high with 'new infection' accounting for the majority of infections present at calving. Minor pathogens again predominated at calving.

Table 7 Antibiotic use outcomes by treatment group

Treatment Group	n	Infected at Drying Off	Number Cured	Number not Cured	Apparent Cure Rate	Number of Antibiotic Tubes Used	Tubes /Cure
Infected Cow Category at Drying Off							
SCLT[1, a]	496	53	49	3	92.5	496	10.12
SQLT1[2, b]	484	68	66	2	97.1	334	5.06
SQLT2[3, b]	528	64	62	2	96.9	240	3.87
Uninfected Cow Category at Drying Off							
SQLT1[a]	511	49	49	0	100.0	159	3.24
SQLT2[b]	518	33	32	1	97.0	65	2.03
SCLT[c]	496	30	29	1	96.7	0	-

This study suggests that the impact of selecting treatments at the quarter level appears to be different in the different infection categories. Overall, the primary effect seems to be on SCC and minor pathogens, rather than major pathogens – multivariable analysis did not detect a significant difference in major pathogen prevalence between treatment groups in either the 'infected' or 'uninfected' cow categories. Therefore, there appears to be little justification for superimposing antibiotic treatment on a teat sealant in low SCC cows at drying off, as self-cure rates appear to be very high and major pathogen prevalence is low – removal of minor pathogens and further SCC reduction is probably not sufficient justification alone. In addition, in herds such as the ones in this study, there appears to be little risk associated with the removal of antibiotic from very low SCC (CMT score 0) quarters in "infected" (high SCC) cows, as there is little if no impact on SCC post calving and little effect on apparent cure rates of major pathogens.

Whilst bacterial culture is still considered the gold standard for detecting intramammary infection, based on the findings of this study, the CMT would appear to be a cheap, rapid and viable, albeit imperfect, way of targeting infected quarters at drying off. Importantly, through its low cost and convenience the CMT offers the opportunity to remove one of the barriers to selective DCT at the quarter level.

Our findings suggest that on well managed low SCC farms, with a low prevalence of major pathogens, the selective use of antibiotic DCT at the quarter level in infected high SCC cows at dry off could result in a substantial reduction in antibiotic use with only minor consequences for udder health. However, in such herds, the superimposition of antibiotic on high SCC quarters in low SCC cows is not necessary and is unlikely to result in significant gains in udder health.

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ACKNOWLEDGEMENTS

The authors gratefully acknowledge the financial support provided by MERCK for this study, the contribution of laboratory and technical staff and participating farmers.

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Proceedings of the British Mastitis Conference (2020) Sixways, Worcester, p 11 - 17
The Dairy Group, The University of Nottingham, QMMS and BCVA

AN UPDATE ON MINOR AND MAJOR MASTITIS PATHOGENS

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INTRODUCTION

Mastitis pathogens have traditionally been stratified in so-called *minor* and *major* mastitis pathogens. Major pathogens are typically able to cause (severe) clinical mastitis cases and result in distinctly elevated somatic cell counts (SCC) when causing subclinical mastitis. Minor pathogens are typically not associated with clinical mastitis, yet when they are, the cases are mild, and result in only a moderate increase in SCC when causing subclinical mastitis. Examples of major pathogens are *Staphylococcus aureus*, *Streptococcus agalactiae*, *Streptococcus uberis*, *Escherichia coli*, *Mycoplasma bovis* and two potential new kids on the block being *Lactococcus lactis* and *Streptococcus bovimastitidis*. *Corynebacterium bovis* and the non-*aureus* staphylococci are the minor mastitis pathogens. In this paper the latest findings on some of the mentioned pathogens are presented.

STREPTOCOCCUS AGALACTIAE

Group B Streptococcus or *Streptococcus agalactiae* can infect multiple hosts including humans and bovine (1). This organism is considered to be a highly contagious bovine mastitis pathogen and was a major cause of mastitis in dairy herds in the pre-antibiotic era (2). Today it is a re-emerging pathogen in European countries with longstanding mastitis control programs (3). Mastitis caused by this streptococcal species in dairy cows is usually chronic and subclinical, with intermittent episodes of clinical mastitis (4). Eradication from individual herds has been seen as practical and cost effective, especially because *S. agalactiae* has always been considered an obligate bacterium of the mammary gland which means that, in nature, it can only live and reproduce in the gland (3). However, the paradigm that *S. agalactiae* is an obligate intramammary pathogen of dairy cattle was shattered in a recent study (5). This Nordic study demonstrated that dairy cattle managed in free-stall herds commonly carry *S. agalactiae* in their gastrointestinal tract suggesting that orofecal transmission of *S. agalactiae* may be of epidemiological significance. The study was actually initiated because of the finding that many free-stall herds in Norway (as opposed to tie-stall herds) failed to eradicate *S. agalactiae* despite the implementation of long-term control measures (however not including blanket dry cow therapy as this is not recommended in Norway). Actually, eradication of *S. agalactiae* on a herd with a good compliance of mastitis control recommendations was only successful once measures to control environmental transmission were implemented. The authors concluded that a cycle of intestinal or rectal colonization, contamination of the environment and reinfection through the orofecal route, possibly via contaminated water troughs is possible. It is not surprising, therefore, that eradication and control programs for *S. agalactiae* that focus exclusively on udder and milking hygiene may fail (5). A more recent paper also challenged the idea that *S. agalactiae* is a highly contagious pathogens as sporadic rather than repeated isolation of *S. agalactiae* from bulk tank milk in 40% of positive Colombian dairy herds was observed (1). As well, *S. agalactiae* was often isolated from rectal or environmental samples demonstrating that it can survive in extramammary sources and is not an obligate intramammary pathogen, as was once believed.

Not only focussing on contagious transmission but also considering the environment of the cows is the lesson to be learned when dealing with a *S. agalactiae* mastitis problem.

STREPTOCOCCUS UBERIS

Streptococcus uberis is an important cause of and subclinical mastitis in dairy cows and has been isolated from the bovine skin, lips, tonsils, the respiratory tract, the rumen, the teat skin and teat canal, the udder, the rectum, and faeces (6). Usual sources of isolation on the dairy farm include soil, water, pasture, cow's high traffic areas such as alleyways and holding pen floors (7). The use of organic material, mainly straw, favours the growth of *S. uberis* (8) resulting in higher incidence of *S. uberis* intramammary infection (IMI). All this indicates that *S. uberis* has acquired mechanisms to adapt and survive in different environments, making it a very versatile and opportunistic pathogen (7). In that respect, the "environmental only" tag of *S. uberis* as a mastitis pathogen has been challenged. A report on a *S. uberis* mastitis outbreak already suggested contagious transmission in 2001 (9). Arguments provided in the paper in favour of contagious transmission included the significance of infection prevalence as predictor for the number of new *S. uberis* IMI, and the decrease in predicted number of new IMI during periods that post-milking teat disinfection was applied. A very recent paper describes a longitudinal observational study to explore transmission dynamics and duration of *S. uberis* IMI (10). Based on results of strain-typing using pulsed-field gel electrophoresis (PFGE), 66 episodes of *S. uberis* IMI were determined. From the main PFGE types, 6 had only one episode indicating no evidence for transmission, subsequently defined as environmental *S. uberis* strains. In contrast, 4 other PFGE types had at least 2 infection episodes caused by the same strain in different quarters or cows, indicating that these strains would be able to transmit to other quarters or cows, once again suggesting the existence of contagious *S. uberis* strains (10).

Since there is evidence that *S. uberis* can behave as an environmental and as a contagious pathogen, control measures should be focused on the control of environmental sources that act as reservoirs, as well as reducing cow-to-cow transmission particularly during the milking process (7).

LACTOCOCCUS LACTIS

Lactococcus species are counted among a large and closely related group of environmental streptococci and streptococci-like bacteria that include bovine mastitis pathogenic *Streptococcus*, *Enterococcus*, and *Aerococcus* species (11). Still, the presence of *Lactococcus* spp. on dairy farms as a potential cause of clinical and subclinical mastitis may have been underreported because identification of species within the aforementioned group can be inaccurate and unreliable (12).

Previously, *Lactococcus lactis* was seen as non-pathogenic starter, a microorganism that is used in the production of cultured dairy products such as yogurt and cheese and has even been used as live culture suspension to treat naturally infected mastitic cows with some success (13). Today it is seen as a potential mastitis causing pathogen. In a recent study, molecular genetic identification methods accurately differentiated 60 environmental streptococci and streptococci-like bacteria isolated from cows with high SCC and chronic IMI among 5 geographically distinct farms in New York and Minnesota that exhibited an observed increase in IMI (11). A predominance of *Lactococcus lactis* subspecies *lactis* (70% of the isolates) was identified in association with chronic, clinical bovine IMI among all farms. In another paper reporting on an outbreak investigation, *L. lactis* (27 isolates) and *Lactococcus garvieae* (1 isolate) were obtained from 28 mastitic cows (14). Strain-typing of the *L. lactis* isolates suggested they originated from multiple reservoirs, a finding that was substantiated by the fact that *Lactococcus* was detected in all environmental samples (mainly sand bedding).

Still, prepartum application in heifers of a teat dip containing lactic acid bacteria, including *L. lactis* subspecies *lactis* along with *Lactobacillus* spp., has recently been shown to be effective to some extent in the prevention of major pathogen IMI and clinical mastitis after calving (15). This finding combined with studies suggesting *L. lactis* causes mastitis, leaves the question on the true importance of this organism open.

STREPTOCOCCUS BOVIMASTITIDIS

Only recently, a new mastitis causing pathogen, called *Streptococcus bovimastitidis*, was described (16). While performing whole genome sequencing on a collection of *S. uberis* isolates collected during two clinical mastitis trials in New Zealand, it became apparent that one of the isolates had failed to be identified as *S. uberis* or any other species in the reference library. The isolate was obtained from a clinical case of mastitis that was undistinguishable from *S. uberis* in its presentation (17). Based on whole genome sequencing, 16s rRNA DNA sequencing, DNA-DNA hybridization and biochemical profiling it was decided the isolate constituted a new species that was sufficiently different to all other know species of streptococci. Its closest relatives were shown to be *Streptococcus porcinus*, *Streptococcus* *pseudoporcinus*, *S. uberis*, and *Streptococcus iniae*. The fact it was the only time it was isolated, suggests that it is not a particularly significant bovine pathogen although in the future this might be different.

NON-*AUREUS* STAPHYLOCOCCI

Alongside a reduction in clinical and subclinical mastitis caused by *S. aureus* and *S. agalactiae* over the last decades, a shift towards a higher prevalence and incidence of mastitis caused by the so-called environmental pathogens and the non-*aureus* staphylococci (NAS) pushed through. Nowadays, NAS have become the principal cause of subclinical mastitis on many dairy farms that have controlled contagious mastitis. Five NAS species are commonly cultured from milk samples: *Staphylococcus chromogenes*, *Staphylococcus epidermidis*, *Staphylococcus haemolyticus*, *Staphylococcus simulans* and *Staphylococcus xylosus* (18). Among other things, recent work on bovine NAS and udder health has focussed on the relation between NAS IMI and milk yield, on NAS from rectal faeces as a potential infection source for the mammary gland, on crosstalk between NAS and *S. aureus*, and on the potential of NAS to produce bacteriocins.

To evaluate the effect of NAS on the quarter milk SCC and quarter milk yield a longitudinal study sampling quarters of heifers milked on robotic milking herds, was conducted (19). Using strain-typing it was possible to distinguish transient from persistent IMI. Eighteen out of 40 IMI (45%) caused by *S. chromogenes* persisted for at least 2 sampling days (14 days apart), while this was only 10 out of 102 (9.8%) for the other NAS species, substantiating *S. chromogenes* is more relevant for udder health. No significant differences in quarter milk yield were observed between quarters having a persistent or transient IMI with *S. chromogenes* or with the group of other NAS species compared with noninfected quarters, despite the higher cell count. Surprisingly, quarters that cured from an IMI with *S. chromogenes* had significantly produced less than noninfected quarters (19).

The presence of NAS in bovine rectal faeces was recently described (20). It was hypothesised that, similar to other mastitis causing pathogens, faecal shedding of NAS could eventually result in IMI. To test this hypothesis, samples were collected cross-sectionally from quarter milk, teat apices, and rectal faeces on 5 dairy herds (21). Samples from clinical mastitis cases were collected as well. For *S. chromogenes*, *S. cohnii*, *S. devriesei*, and *S. haemolyticus*, the same strains were found in rectal faeces, on teat apices and in quarter milk, indicating that NAS with a faecal origin can infect the mammary gland.

A paper in which NAS crosstalk with *S. aureus* was studied, reported that out of 81 NAS supernatants, 77% reduced the expression of hla (encoding a-hemolysin), 70% reduced the expression of RNAIII (key effector molecule of the accessory gene regulator quorum sensing system of *S. aureus*, controlling virulence factors), and 61% reduced the expression of spa (encoding protein

A) of *S. aureus* (22). Our own unpublished data suggest that downregulation of the RNAIII gene of *S. aureus* by NAS is species-dependent and only partially works through growth inhibition (e.g. exerted by bacteriocin production) (Silva et al., unpublished data). The knowledge of how NAS influence *S. aureus* virulence factor expression could explain the varying protective effect of NAS against *S. aureus* IMI (22).

The inhibitory capability of 441 bovine NAS isolates (comprising 26 species) against bovine *S. aureus* was recently studied (23). Forty isolates from 9 species (*S. capitis*, *S. chromogenes*, *S. epidermidis*, *S. pasteuri*, *S. saprophyticus*, *S. sciuri*, *S. simulans*, *S. warneri*, and *S. xylosus*) inhibited growth of *S. aureus in vitro*, 23 isolates of which, from *S. capitis*, *S. chromogenes*, *S. epidermidis*, *S. pasteuri*, *S. simulans*, and *S. xylosus*, also inhibited MRSA. One hundred five putative bacteriocin gene clusters encompassing 6 different classes (lanthipeptides, sactipeptides, lasso peptides, class IIa, class IIc, and class IId) in 95 whole genomes from 16 species were identified and a total of 25 novel bacteriocin precursors were described. The authors concluded that prospective clinical applications might become a possibility.

CONCLUSIONS

All in all, recent work has shown that a bimodal stratification of mastitis pathogens [called “a black-and-white dichotomy” by Zadoks and Schukken (24)] - be it major or minor pathogens - in so-called contagious or environmental pathogens, is not a true reflection of the ecology and epidemiology of mastitis pathogens as we know today. *Streptococcus agalactiae*, once believed to be a highly contagious and obligate intramammary pathogen that could easily be eradicated from dairy herds, can also present itself as an opportunistic, less contagious organism, surviving not only in the mammary gland of cows but also in the environment. The same is true for *S. uberis*, once believed to be a true environmental pathogen yet today we know that contagious *S. uberis* may occur as well.

Also, NAS have traditionally been seen as teat skin colonizers, being classified somewhere in between contagious and environmental in origin. However, species-specific research performed over the last 10 years has revealed that some species are much more host-adapted (and likely contagious, such as *S. chromogenes*) than others (such as *S. fleurettii*). Still, an orofecal transmission route is also suspected for NAS as faecal shedding has been confirmed, with the same strains being present in faecal samples, on the teat end and in milk samples. More recent NAS work has focussed on the (species-specific) association with udder health and milk yield, substantiating that NAS IMI results in moderately elevated SCC yet not with a reduced milk yield. Combining the latter finding with the fact that many NAS harbour bacteriocin gene clusters, warrants further study.

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Proceedings of the British Mastitis Conference (2020) Sixways, Worcester, p 19 - 20
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DYNAMIC VACUUM CONTROL STRATEGIES AND REVIEW OF ISO GUIDELINES FOR MILKING VACUUM

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DeLaval has introduced new technology that adjusts milking vacuum level according to milk flowrate. In a conventional milking system, milking vacuum drops as milk flowrate increases resulting in the highest milking vacuum occurring at the lowest milk flowrate (beginning and end of milking). The ISO standards and guidelines for milking vacuum level were developed assuming this relationship. When Flow-controlled Vacuum (FCV) is applied this relationship is reversed and the highest milking vacuum occurs during the peak flow period of milking.

When FCV was applied to conventional clusters on a commercial farm with a rotary milking parlour peak milk flowrate increased by 12% and average milk flowrate increased by 4% at the udder level, with no meaningful differences in post-milking teat condition. When FCV was applied in a quarter-milking automatic milking system on a commercial farm average milk flowrate increase by 4% and milking duration was reduced by 4%. The effects were more pronounced in slow milking and low yield quarters resulting in more uniform milking of quarters. The control strategies and vacuum levels for the parlor and AMS applications are summarized below:

	Parlour Udder/cluster Level	**AMS Quarter/teatcup level**
Low Flow Period Milk Flowrate	0.4 - 2 kg/min	0.2 - 0.5 kg/min
Low Flow Vacuum	38 - 40 kPa	41 - 42 kPa
Peak Flow Period Milk Flowrate	2 - 5 kg/min	0.5 to 1.5 kg/min
Peak Flow Period Vacuum	41 to 42 kPa	42 to 46 kPa

The range of milking vacuum levels recommended by ISO, ASABE, and NMC is:

> *Both research and field experience indicate that a mean liner vacuum within the range 32 kPa to 42 kPa during the peak flow period of milking for cows ensures that most cows will be milked quickly, gently and completely.*

These guidelines were developed for milking machines that maintain a constant ‘system’ vacuum and for typical vacuum drop relationships for commercial milking machines. While these guidelines are specified for the peak flow period of milking, the milking vacuum level during the low flow period of milking is also important, especially when over-milking or substantial cups-on time is spent in low-flow conditions. General categories to describe milking vacuum levels in both the peak and low flow periods of milking for conventional milking systems with teat end vacuum drop proportional to milk flowrate presented by Mein and Reinemann (2015) as:

Teat-end Vacuum Classification	**Peak Flowrate Period**	**Low Flowrate Period**
Low	32-36 kPa	40 kPa
Moderate	36-40 kPa	40-46 kPa
High	40-44 Pa	>46 kPa

The milking vacuum for the FCV milking parlour application is within the ISO guidelines for milking vacuum during the peak flow period and would be classified by Mein and Reinemann (2015) as low vacuum during the low-flow period and high vacuum during the peak-flow period.

Because teatcup removal was done at the quarter level in the AMS application, thus eliminating over-milking of quarters, a higher vacuum level was applied during the peak flow period in the AMS than in the parlour application. The milking vacuum level in the AMS would be classified by Mein and Reinemann (2015) as moderate during the low-flow and high during the peak-flow period of milking.

There were no meaningful differences is post-milking teat conditions between the use of FCV systems described above and conventional vacuum control. These results emphasize results of other research indicating that the majority of teat tissue stress occurs during the low flow period at the end of milking, and that the degree of over-milking is a significant risk for teat tissue stress. Although the vacuum level in the AMS during the peak flow period was higher than the ISO recommendation, moderate vacuum during the low flow period and the elimination of overmilking by quarter teatcup removal appears to have provided protection from teat tissue stress.

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Proceedings of the British Mastitis Conference (2019) Sixways, Worcester, p 21 - 22
The Dairy Group, The University of Nottingham, QMMS and BCVA

APPLYING INTERNAL TEAT SEALANTS AT DRYING OFF; DOES FULL VERSUS PARTIAL INSERTION OF THE TUBE CANNULA MATTER?

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OBJECTIVES

Internal teat sealant (ITS) and intramammary antibiotic application tubes can often be used with either a short or a long insertion cannula. Leelahapongsathon et al (2016) found that intramammary infection in early postpartum was significantly associated with full cannula insertion for the administration of antibiotic dry cow therapy (ADCT). There is a lack of published work on the effect of using full (FI) or partial (PI) cannula insertion for the administration of ITS. Our randomised control trial aimed to test the hypothesis that FI could increase the risk of introducing new infections into the udder leading to higher somatic cell counts (SCC) post-calving and a greater incidence of mastitis post calving comparing to PI.

MATERIALS AND METHODS

Three pedigree Holstein UK dairy farms were selected to take part in the study over a period of six months. The farmers selected which cows were to be dried off each week and dictated whether each cow would receive internal teat sealant only (ITS, Ubroseal® Boehringer Ingelheim Animal Health UK Ltd) or intramammary antibiotic and internal teat sealant (AB+ITS). Cows were then randomised to receive ITS or AB+ITS via either FI or PI of the cannula/e. The facilitator was blinded to the insertion type until the cow was enrolled. One farm opted to only allow enrolment of cows receiving ITS as the antibiotic tubes used at dry off did not have the option of partial cannula insertion. The facilitator was trained in best practise aseptic technique for drying-off cows by three different experts in the field. All farms milk recorded monthly and the SCC data collected was collated along with incidence of mastitis within 30 days of calving. Cure rates (cows with SCC>200K cells/ml before drying off having a first test of SCC<200k cells/ ml after calving) and new infection rates (cows with SCC<200K cells/ml before drying off having a first test of SCC>200k cells/ ml after calving) were calculated from these data. Univariable and multivariable regression analyses were employed for data analysis.

RESULTS

287 cows were included in the study, 47% of the cows received full insertion of the cannula/e (n = 135), 30% of the cows received AB+ITS as allocated by

the farmers (n = 86). There was no evidence to allow us to reject the null hypothesis; there was no difference in post-calving SCC, new infection rates, cure rates, or mastitis incidence when comparing FI versus PI. With regards to cows with low SCC before drying off, cows receiving PI were 1.01 times as likely to have high SCC post calving as cows receiving FI (95% confidence interval (CI): 0.42 to 2.46, $P = 0.98$). Cows in their second or greater lactation and cows calving in the Spring or Summer were more likely to acquire a new infection compared to cows in their first lactation and cows calving in the Autumn respectively. Factors associated with a high SCC post calving were: calving season, infection status before drying off, and lactation group; treatment (PI vs FI) was not statistically significantly associated with this outcome either. PI versus FI was also not associated with the cure rate post calving (cows receiving PI were 1.45 times as likely to have low SCC post calving as cows receiving FI; 95% CI: 0.30 to 7.06, $P = 0.65$). Cows in their first lactation were 9.86 times more likely to cure an infection comparing to older cows (CI: 0.83 – 117.62, $P = 0.07$). Cows in their second or greater lactation were 5.23 times more likely to be diagnosed with clinical mastitis the first month after calving comparing to cows in their first lactation (CI: 1.34-20.31, $P = 0.017$). Treatment (PI vs FI) was not associated with mastitis incidence.

CONCLUSIONS

In conclusion this study showed that when the correct aseptic technique is used for drying cows off there is no difference in post-calving infection status or mastitis incidence when comparing FI versus PI.

ACKNOWLEDGEMENTS

This study was funded by Boehringer Ingelheim Animal Health UK Ltd. The funder was involved in the study design but not in data collection and analysis.

NOTES

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INJECTIONS OF PENETHAMATE (PERMACYL®) FOR THE TREATMENT OF CLINICAL MASTITIS IN LACTATING DAIRY COWS IN ASSOCIATION OR NOT WITH AN INTRAMAMMARY SUSPENSION OF CEFALEXIN+KANAMYCIN (UBROLEXIN®)

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SUMMARY

A total of 150 cows suffering from clinical mastitis were enrolled from 16 Italian farms. According to randomization and in blind conditions, half of the animals received Permacyl® alone and FIELD EVALUATION OF THE EFFICACY OF INTRAMUSCULAR the other half received the association of Permacyl® + Ubrolexin®. No other therapy was permitted. Enrolled animals were monitored by the investigator for 84 days with regular clinical examinations, milk samples collected for bacteriological analysis and SCC.

Clinical and bacteriological results showed very satisfactory high efficacy level in both treatment groups (> 75% for bacteriological and > 82% for clinical endpoints). When a difference was observed between groups it was close to 5% in favour of the association but these differences were never statistically significant.

The study confirmed the efficacy and safety of Permacyl® administered intramuscularly alone or combined with intramammary administration of Ubrolexin® for the treatment of clinical mastitis in lactating dairy cows.

INTRODUCTION

The aim of this study was to compare the efficacy of a penethamate suspension in association or not with an intramammary suspension of cefalexin+kanamycin in cows suffering from clinical mastitis.

MATERIALS & METHODS

To be enrolled cows had to present clinical signs of mastitis in one quarter only and not require additional treatment (e.g. fluids, NSAID, etc) other than those investigated in the study. A total of 150 cows from 16 Italian farms were enrolled and randomized (76 cows in the Permacyl® group and 74 in the Permacyl® + Ubrolexin® one). The study was blinded; with an administrator, not involved in clinical assessments, who dispensed all drugs. Table 1 presents a summary of the study events. Groups were homogenous at inclusion.

Table 1 Table of events

	D0	D1	D2	D3	D4	D7	D14	D28	D56	D84
Clinical exam	X	X	X	X	X	(X)	X	X	X	X
Milk bacteriology	X			X	X		X	X	X	X
Somatic cell count	X							X	X	X
Permacyl® adm.	X	X	X	(X)						
Ubrolexin® adm.	X	X								

(X) not mandatory (i.e. at the investigator's discretion)

RESULTS

Main efficacy results are summarized in Table 2

Table 2 Comparison between treatment groups

	Permacyl® alone	Permacyl® + Ubrolexin®	P value
Bacteriological cure at D14	75.8% (25/33)	75.0% (30/40)	P = 0.94 Chi square test
Bacteriological relapse	0% (0/25)	3.3% (1/30)	P > 0.99 Chi square test
New intra-mammary infections	1.3% (1/75)	1.4% (1/72)	P > 0.99 Fisher's exact test
Clinical cure at D14	82.7% (62/75)	87.5% (63/72)	P=0.41 Chi square test
Clinical relapse	11.3% (7/62)	6.4% (4/63)	P=0.33 Chi square test
Clinical cure at D14 without Gram negative cases	82.4% (56/68)	87.9% (51/58)	P=0.38 Chi square test
Time to clinical cure	Log rank test		P = 0.86
Time course of somatic cell counts	Mixed model of ANOVA		P= 0.19 for the treatment effect

CONCLUSION

This study allowed to conclude that intramuscular administration of Permacyl® alone or combined with local application of Ubrolexin® is safe and efficacious for the treatment of clinical mastitis in lactating dairy cows.

NOTES

Proceedings of the British Mastitis Conference (2019) Sixways, Worcester, p 25 - 26
The Dairy Group, The University of Nottingham, QMMS and BCVA

HIGH SOMATIC CELL COUNTS ARE NOT ALWAYS A CONSEQUENCE OF INTRAMAMMARY INFECTIONS; A REVIEW

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SUMMARY

Dairy cows given intravenous injections of lipopolysaccharide were shown to have elevated somatic cell counts (SCC). This suggests that milk SCC can be increased in absence of microbial infections of the mammary gland. These findings may suggest that common pathological conditions seen in dairy cows that causes inflammation may have also contribute to the milk SCC. Many of these conditions are associated with compromised epithelial barriers allowing bacteria and bacterial fragments to cross into the systemic circulation. Supplemental metal amino acid complexes have been shown to improve epithelial integrity and help to control inflammation. Along with effective management of environment and nutrition this may be an effective way to control inflammation, SCC and reduce the losses in production performance associated with it.

INTRODUCTION

In most cases high somatic cell counts are associated with microbial infections of the mammary gland. However, there is evidence to suggest there are instances where an increase in SCC is not directly related to the presence of a pathogen. Recently Horst *et al.,* (2019) reported that an intravenous lipopolysaccharide (LPS) challenge given to lactating Holstein dairy cows was able to elicit a significant increase in milk SCC, which was associated with a systemic inflammatory response. Many conditions cause systemic inflammation including obesity (Koster and Opsomer 2012) and excessive lipolysis (Contreras *et al.,* 2018). Inflammation can also result in repartitioning of nutrients away from milk production (Kvidera *et al.,*2014, Waldron *et al.*, 2004). This review discusses the possibility that preventing systemic inflammation may also help control milk SCC and maintain milk output.

EFFECT OF PATHOLOGICAL CONDITIONS ON INFLAMMATION

A number of pathological states have been shown to increase the level of systemic inflammation. Heat stress (Koch et al., 2019), hind gut acidosis (Tao *et al.* 2014), lameness (Herzberg *et al.,* 2020) metritis and endometritis (Sheldon, 2016).

TRACE MINERAL NUTRITION CAN HELP TO CONTROL INFLAMMATION

Administration of LPS resulted in systemic inflammation characterised by significant increases in serum amyloid A (SAA), LPS binding protein (LBP) and cortisol. A significant increase in milk SCC was also observed in the challenged cows despite the fact that LPS was administered intravenously. Interestingly, cows fed zinc in the form of metal amino acid chelate (Availa®Zn) had lower milk SCC and returned to pre challenge SCC levels earlier than cows supplemented with iso levels of zinc in the form of zinc sulphate. (Horst *et al.,*2019). This demonstrates that zinc source can also have a profound effect on the ability of the immune system to deal with inflammatory states.

IMPROVING EPITHELIAL INTEGRITY CAN REDUCE THE DEGREE OF INFLAMMATION

Many of the pathological conditions which are responsible for systemic inflammation are associated with morphological damage and changes in the cellular architecture of epithelial tissues. Inflammation in these tissues can be profound because of the intense localisation of immune components. (Sanz-Fernandez *et al.,* 2020). Trace mineral source has been shown to have a significant positive effect on maintaining epithelial integrity in swine and steers.

SUPPLEMENTING ANIMALS WITH METAL AMINO ACID CHELATE (AVAILA®Zn) HAS A POSITIVE EFFECT ON GUT INTEGRITY

Supplementing growing pigs with 60ppm of metal amino acid chelate (Availa®Zn) instead of zinc sulphate was shown to reduce the impact of heat stress and feed restriction on gut epithelial integrity (Pearce *et al.,* 2015). This was characterised by reduced epithelial permeability, increased trans epithelial resistance and lower circulating serum endotoxin. In steers (Abuajamieh et al., 2016) exposed to heat stress and feed restriction, supplementation with 40 ppm metal amino acid chelate (Availa®Zn) helped to maintain normal intestinal epithelial cell morphology compared to steers fed iso levels of zinc sulphate. Epithelial cells from supplemented animals had a greater villi height to width ratio – an indicator of healthy epithelium.

CONCLUSION

Based on the evidence available it is not inconceivable that elevated SCC can be caused by inflammatory responses to insults outside of the mammary gland in tissues such as the gut epithelium. The impact of these insults can be mitigated by effective management interventions. For example, providing balanced diets that promote a healthy gut and preventing heat stress. Providing an effective trace mineral nutrition with metal amino acid chelate (Availa®Minerals) can also have a positive effect on maintaining epithelial integrity, reducing the severity of inflammation and supporting rapid resolution of a normal inflammatory state.

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Proceedings of the British Mastitis Conference (2020) Sixways, Worcester, p 27- 31
The Dairy Group, The University of Nottingham, QMMS and BCVA

INSPIRING AND SUPPORTING CHANGE ON FARM: MAKING IT HAPPEN!

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SUMMARY

The gap between science and practice is often cited as a cause of poor uptake of advice, low technology adoption rates, reluctance to change behaviours and poor compliance with regulation. Agricultural Extension aims to reduce this gap and has evolved significantly over the last few decades to become more participatory and bottom-up, reflected in the relatively new title of knowledge exchange. This study aimed to understand how a participatory approach based on the Danish Stable Schools could help to achieve practical, farmer-led changes that reduced reliance on antimicrobials in the UK, which is fully described by Morgans and colleagues (17, 18). Five facilitated Farmer Action Groups comprising 30 dairy farms across South West England met on farm at regular intervals between 2016 – 2018 and worked collaboratively within their groups to discuss how to reduce antimicrobial use. Thirty practical action plans were co-developed by the groups with 83.3% implementing more than a third of the action plan within a year. Farmers particularly valued the peer-to-peer learning during farm walks and facilitated discussions, which empowered them to change practices. Participants identified knowledge gaps during the project, particularly on highest priority critically important antibiotics. Facilitated, farmer-led, participatory approaches that mobilize different forms of knowledge and encourage peer learning are a promising way of inspiring and supporting change on farm, with and by farmers.

INTRODUCTION

"I just get frustrated with the fact that they'll never see…a lot of them don't see the size of the problems they've got in front of them." UK veterinarian.

The gap between science and farming practice causes much frustration when it comes to bringing about change (20). Scientific endeavour and the associated publications and knowledge dissemination is often conducted in academic institutes or centres far removed from most farming daily life. The contexts, challenges and drivers on individual farms that affect uptake of new research or advice are rarely considered in the design and implementation of research studies (3, 21). This gap manifests in many different subject areas, such as technology development in the Agri-tech world (14) and research into Antimicrobial Resistance (13). It is also reflected in agricultural policy where engagement with those that policy aims to influence (i.e. farmers) is seen as necessary but seldom achieved (10).

Agricultural extension, now commonly referred to as Knowledge Exchange in the UK, has been the main mechanism to reduce the science-practice gap (11). To understand a bit more about why such a gap exists it is necessary to look back at its history. After World War Two, there was a desperate need for food and increased agricultural productivity. There was a focus on science and technology finding the solutions to achieving increased output, with agricultural extensionists playing the role of transferring these expert-led solutions down to the lay person, (i.e. the farmer) for them to adopt on farm and thus increase productivity (19). These solutions were scientist-led; designed, tested and analysed on research platforms and institutes far removed from context-dependent field trials. The process was called the Transfer of Technology model and did arguably result in symbolic changes within farming, such as mechanization (5).

However, this model of extension began to show limitations as uptake of new knowledge and research was not progressing as expected (5, 9, 20). Social science research on the nature of knowledge and criticism of the expert-lay divide began emerging at the same time (1). Social theorists, such as Michel Focault began questioning whose knowledge mattered, who are the experts (6) and what is the relationship between knowledge and power (22)?

This gave birth to new models of extension, such as the Agricultural Knowledge Innovation System (AKIS) (8). A desire to conduct research with farmers instead of simply about them gained traction across the world with the work of Chambers and Scoones in the Farmer-First-and-Last Model (5, 22) The FAO began a global participatory programme called Farmer Field Schools that still run today, which has reached over 12million farmers in 90 countries. This bottom-up model differs substantially to what had gone before by prioritising farmer knowledge in finding solutions to farm-specific challenges. Our understanding and practice of agricultural extension has evolved to be less top-down and one-way in transferring information and 'expert' knowledge to farmers, and to be more collaborative, two-way and participatory.

Knowledge acquisition and exchange is central to changing practices on farms and has a critical role in agricultural innovation (7, 11). Knowledge comes in different forms and is dependent on an individual's perspective and epistemological paradigm (i.e. one's worldview about the nature of knowledge and how we generate knowledge) (16). The knowledge commonly associated with veterinary and agricultural science is largely positivist and empirical. Positivistic approaches aim to generalize about phenomenon over time and between different contexts with a focus on discovering one objective truth about the natural world (16). Adopting a social science approach requires an openness to other understandings of knowledge, knowledge generation and knowledge transfer (4, 19). Epistemology is important here because it determines how researchers frame their study design, as well as how they interpret and apply their results. One question asked by the research presented in this paper was, 'How do farmers generate knowledge to enact change?'.

Adopting novel and innovative research methodologies - with groups of farmers being central to the process of finding solutions to complex challenges (12) - can also be seen in other disciplines, like psychology and medicine, where the use of patient-centric techniques is expanding (e.g. Motivational Interviewing) (15). There is a need in the veterinary literature to widen our perspective or way of looking at problems to account for context (3) so that we can enact real change. Participatory, bottom-up approaches offer a framework and alternative knowledge exchange methodology that responds to the criticisms described above to influence and shape practices on farm.

MATERIALS & METHODS

This paper presents the key findings from a primarily longitudinal case study involving an established participatory methodology (2, 23) using mixed methods (i.e. qualitative and quantitative data collection and analysis). It uses a convenience sample of volunteers, has no control groups or randomisation and as such does not aim to generalise but to improve our understanding about how to inspire change on farm. Further detailed information on the methodology and analysis can be found in (17, 18).

RESULTS

Full results and discussion can be found in (17, 18).

CONCLUSIONS

Farmer Action Groups are another example of a participatory, farmer-led approach to instigating and supporting changes to practice on farms. The study highlighted here is a novel use of the approach in the context of reducing AMU on UK dairy farms, of which a full published version can be found (17, 18). This study supports the growing literature on the validity and power of bottom-up approaches in varying contexts. The Farmer Action Groups differ to traditional advisory and extension services by prioritising and promoting farmer expertise in identifying and solving farm specific challenges. There were no lectures, PowerPoints or external speakers. The farmers were the experts. Participants demonstrated their ability to change practices on farm to reduce their reliance on antimicrobials through the co-creation of 30 Action Plans covering a wide range of topics with the majority implementing over a third of the Action Plans within a year. Many participants found the project facilitation and participatory mechanisms helpful in prioritising tasks and learning from their peer group. A key outcome for farmers was the new knowledge they generated from participation rather than from their veterinarians, which contributed to farmers' efforts to shift away from HPCIA. A farmer-led, participatory approach which prioritises farmer expertise and supports knowledge mobilization by professionally trained facilitators is one way of initiating and supporting change with farmers.

ACKNOWLEDGEMENTS

The study was primarily funded by the Agriculture and Horticulture Development Board for Dairy - who have a direct interest in the approach as a knowledge exchange organisation - and partially funded by the Langford Trust. The study was conducted at the University of Bristol and supervised by Dr Kristen Reyher, Professor David Main, Professor Henry Buller and Dr Maria Escobar. The author would like to thank all the dairy farmers who took part in the farmer action groups and the veterinarians and advisors who participated in the study.

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Proceedings of the British Mastitis Conference (2020) Sixways, Worcester, p 33- 40
The Dairy Group, The University of Nottingham, QMMS and BCVA

MASTITIS CONTROL IN AUTOMATIC MILKING SYSTEMS.

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SUMMARY

Automatic Milking Systems (AMS) continue to gain in popularity in the United Kingdom and north-west Europe. The majority of new AMS installations are in existing dairy herds that have previously operated using conventional machine milking. The conversion process allows comparison between udder health performance before and after conversion. A deterioration in udder health is common following the transition to AMS. There are usually multiple causes for this poorer performance, some of which are transitory, others more long lasting. To maintain cow health and milk quality at acceptable levels the specific risk factors associated with automatic milking must be identified, understood and mitigated.

INTRODUCTION

Differing dairy systems and management strategies have specific characteristics that give strengths and weaknesses in different performance areas of the business. Characteristics that allow a farm to excel in one area of health or productivity may also provide challenges in another area of performance. Choosing a system that excels in areas that are a high priority to the business (and only compromises on performance in areas of lower concern) is key to the success of the business and the wellbeing of those working in it.

This basic premise of compromise can be applied to the choice between conventional milking systems (CMS) and AMS. Within each system there is a wide range of performance in each area of health and production but there are some areas where, notwithstanding these overlapping ranges, one system tends to outperform the other. One such area is udder health. AMS herds tend to have poorer udder health than CMS herds with similar non-milking risk factors (Mulder et al, 2004). It is also common to see a deterioration in udder health parameters following conversion from CMS to AMS (Hovinen et al., 2009). This deterioration may be sustained indefinitely, or partially or fully resolve after a short period of time (Rasmussen et al., 2006). Despite some advances in technology in AMS, current performance remains consistent with these earlier findings (Greenham, unpublished observations).

Udder health is a fundamental priority for any dairy system so, in choosing to milk cows with AMS, producers must be aware of the limitations to performance, both to avoid unrealistic expectations and to be able to mitigate the specific udder health risks associated with AMS.

SPECIFIC RISK FACTORS FOR INTRAMAMMARY INFECTION IN AMS

Milking Frequency & Interval

In AMS herds, milking intervals are highly variable between cows with different yields and lactation stage, but there is a general tendency toward more frequent milking and so shorter milking intervals. In CMS herds some studies have demonstrated that interval length is negatively correlated to udder health (Klei et al., 1997) and extended milking intervals have been associated with clinical mastitis in AMS (Rasmussen et al., 2007). However, this can be dependent on whether the benefits of increased milking frequency (improved teat hygiene, lower intra-mammary pressure, reduced opportunity for bacterial colonisation) outweigh potential negative consequences (more periods with an open teat end, increased exposure to fomites, greater cumulative trauma to teat end skin). The relationship between these different factors may explain why the published data can be contradictory as to the udder health benefit of higher milking frequency in AMS.

Variability in milking intervals within individual cows has also been postulated as a risk for poor intra-mammary infection. Diurnal patterns naturally impact on milking interval consistency (Munksgaard et al., 2011). Dominance hierarchies can also have a profound effect on queueing times and milking interval (Halachmi et al., 2009). Variation in milking intervals at cow and/or quarter level leads to corresponding variation in yield and somatic cell count (SCC) at subsequent milkings but it is not fully established whether the variation in SCC is a true indicator of pathology or rather a consequence of dilution or concentration by the altered milk yield. Field observations by this author have seen an association between improved regularity of milking and lower clinical mastitis, but this change is often accompanied by other interventions so is not necessarily causal.

Infrastructure

Various elements of building design and management can influence udder health and AMS have some specific requirements to minimise risk. Within AMS different milking strategies (free access; ‘feed-first’; ‘milk-first’ systems) require different layouts of feed, cubicles and gates. This can present challenges for cow flow, cow-cow interactions, slurry management and foot-bathing.

When installing AMS into new buildings these challenges can be minimised by customising the layout to suit the system. When converting existing buildings to house new AMS it can be problematic to achieve the requirements to optimise cow flow, reduce negative social interactions and effectively manage slurry to minimise exposure of the cows to pathogenic bacteria.

Slurry management must be accomplished with the cows *in situ*, with either automated systems or slatted floors. These solutions can be successful in maintaining environmental hygiene but the more complex the infrastructure (gates, races, etc) the more challenging this becomes. Most AMS have some requirement for manual slurry management in certain areas that are inaccessible by automated systems.

Foot-bathing can be a significant source of bacterial contamination of the udder and the teats. Footbaths need to be sited where every cow will walk through to receive treatment. In free access systems this may require positioning at the AMS box. Siting on entry to the box has a tendency to reduce visits. Siting at the box exit risks contamination of the teat end before full closure of the teat sphincter. Guided traffic systems may have more options for foot-bathing at gateways between feed and lying areas. A challenge for all systems is maintaining an appropriate frequency of foot-bath cleaning and replenishment. With variable cow flow through the bath it can be hard to assess when the contents have become excessively contaminated.

Concurrent Disease

As with cows in any dairy system, concurrent diseases may impact the rate or severity of intramammary infections (IMIs). Conditions which are a particular issue in AMS include lameness and inappropriate trace element status.

Lame cows have a lower visit frequency (Borderas et al., 2008) and much longer queueing times to enter the AMS (Halachmi, 2009). Longer milking intervals may predispose IMI and greater time spent queueing increases the potential for contamination of the udder and teats. Additionally, lame cows will achieve fewer visits to the feed face (particularly in guided traffic systems) altering the intake ratio of concentrate to forage and potentially reducing overall dry matter intake (DMI). Impact on metabolic status and rumen health may have indirect effects on udder health for these individuals.

Trace element imbalances may be found when there is a reliance on concentrate feeding in the AMS box to maintain the desired visit frequency. This is particularly pertinent to free access systems. Some mineral sources are relatively unpalatable and so have been excluded from the concentrates in case they deter cows from visiting the AMS. This can be a problem in herds which achieve a large part of their nutritional intake from box concentrates and proportionally less from the mixed ration/forage (Bach et al., 2007). Deficiency in minerals such as Selenium can increase incidence and severity of clinical mastitis (Yang & Li, 2015). Monitoring of maximum and minimum concentrate: mixed ration ratios should be carried out to allow calculation of mineral provision.

Teat Hygiene

Different AMS models have varying approaches to teat cleaning and disinfection.

The two main pre-milking regimes use revolving brushes or ‘cup-cleaning’, the latter either in a separate cleaning cup or within the milking liner. There is little robust work to show a clear benefit to either type of cleaning. Failure to clean may be due to the teat not getting proper exposure to the cleaning process. Brushing is vulnerable to inaccurate location of the teat. Height settings may be problematic, particularly for herds with a wide range of udder heights. The brush may be too high for low udders, leading to dirt being transferred from the udder skin to the teat. Conversely animals with high udders may only get the lower portion of the teat cleaned. Cup cleaning is vulnerable to kick-offs by restless cows (Jago et al., 2006).

Even when the pre-milking process is performed correctly, there is no guarantee of effective reduction in bacterial load. At the current time, all commercially available methods are standardised, with no ability to vary the cleaning protocol according to teat cleanliness. This inability to respond to heavier soiling with a more effective cleaning is a key weakness for AMS. Sensor technology to allow a response to dirtier teats is currently under development but, until this is successful and commercially available, it remains of paramount importance to minimise teat skin contamination by environmental management.

Post milking disinfection may be performed by cup-dipping or spray application. Spray accuracy is often poor and there is a requirement for diligent monitoring and fine-tuning of spray arm positioning and volume and duration of spraying if adequate skin coverage is to be achieved. Dipping seems likely to be a more reliable form of post-milking teat disinfection but there is a paucity of independent data to support this hypothesis, highlighting an opportunity for further study.

Machine Hygiene

All milking equipment which comes in to contact with the cows’ teats can act as a vector for pathogen, specifically in the case of contagious bacteria such a Staphylococcus aureus. This includes infrastructure for pre-milking teat preparation, as well as the milking liner. In AMS many more cows are milked by the same set of milking liners each day than is commonly seen in CMS. This increases the potential impact of contamination with contagious pathogens. As such, the rate of increase in prevalence of IMIs due to contagious pathogens tends to be higher in AMS than CMS. Increase in Staphylococcus aureus IMI prevalence from three per cent to sixty-seven per cent within a twelve-month period has been described (Zecconi et al., 2005).

Different models of AMS feature various options for disinfecting the cow-facing equipment. Rinsing teat-preparation infrastructure (with and without disinfectant) and hot and cold cleaning of the milking liners between cow milkings are all available to combat fomite spread of pathogens. Unfortunately, at the levels of contamination seen in normal field conditions, these strategies appear to have limited success in reducing pathogen challenge to non-infectious levels (Hovinen et al., 2010).

Early detection of the presence of contagious pathogens is crucial to avoid establishing a high prevalence in the herd that will be difficult and costly to eradicate. Routine monthly or quarterly monitoring for Streptococcus agalactiae by PCR test of the bulk tank milk should be considered. This approach has limitations with Staphylococcus aureus, due to its role as a skin commensal leading to false positives. Individual cows with chronic high somatic cell count are a useful sentinel group for individual milk culture to monitor for Staphylococcus aureus.

If Staphylococcus aureus is found in the AMS herd, widespread targeted testing and early culling may prevent the problem from becoming established within the herd. For high prevalence situations a combination of control measures will be needed, including testing and culling, maximising machine cleaning regimes and optimising the post-milking disinfection efficacy of the AMS. In larger herds, with multiple AMS boxes, splitting the herd into infected and non-infected groups and running these on separate boxes will help reduce spread within the herd.

Milking Conditions

The interaction between machine and cow in AMS tends to be highly consistent between each milking. This means that if the key components of milking are performed correctly the milking process achieves a comfortable and healthy milking for a majority of cow visits. There is very little variation between AMS (of the same model) on different sites compared to the wide range of different configurations of conventional milking machines of the same brand. This means the vacuum settings, pulsation phases, ACR control and liner options are well established, resulting in relatively few AMS installations with inappropriate milking conditions.

Consistent preparation protocols mean incidence of biphasic milk flow is low in AMS herds. Quarter level milking allows detachment to occur when each individual quarter reaches low flow, helping reduce duration of overmilking. Silicon liners are commonly used on AMS (in part due to the greater longevity compared to rubber) and the lower compressive loads associated with silicon compounds contribute to low risk for teat end hyperkeratosis.

In general, milking using AMS technology tends to give a gentle milking with low levels of machine risk factors for IMI. The only potential issue with AMS is the increased chance of a cow not being successfully milked at udder or quarter level. Missed milkings have been demonstrated to cause increased discomfort and higher probability of cows leaking milk whilst lying. An association between unsuccessful milkings and subsequent clinical mastitis has also been observed (Rasmussen et al., 2007). Whilst there is not a large body of evidence to link missed milking directly to increased IMI it seems plausible that this carries a degree of risk for reduced udder health.

Mastitis Detection

Mastitis detection has been an ongoing challenge throughout the development of AMS. As such it has been the subject of extensive research and development. Current diagnostics utilise colorimetry, electrical conductivity, temperature and somatic cell count of various fractions of milk throughout the quarter milking. These sensor data are analysed separately or in combination and processed via various algorithms to generate alerts for the farm team.

Relatively low sensitivity values are tolerated on the basis that, with higher milking frequencies, the quarter will soon receive a repeat test. These lower sensitivities allow a higher specificity to be achieved -an important test feature to prevent too many false positive results which can cause significant disruption to the farm team. Several machine-learning projects have attempted to improve the detection capabilities of AMS with limited success (Cavero et al., 2008). One limitation of many quoted sensitivity and specificity values is that they are often not related to a reliable 'gold-standard' method of mastitis detection.

As a result of inadequate mastitis detection by the AMS, clinical mastitis is frequently under or over detected. These scenarios can lead to poor treatment success, inappropriate medicine use and the generation of inaccurate data that may lead to misguided decision making over preventative interventions at herd level.

It is hoped that future development will further refine the detection success of AMS. Currently, the most successful strategy for mitigating problems caused by detection limitations is to implement proactive measures to reduce the incidence of clinical mastitis.

Treatment Regimes

Established treatment protocols for IMIs in CMS predominantly feature intramammary antimicrobial preparations. Research and development of these intramammary treatments has largely been based on use in cows milked twice daily at regular intervals. There is comparatively little data on the pharmacokinetics of these products in cows that are milked three to five times per day -a not uncommon scenario in AMS. This paucity of data, particularly regarding milk withdrawal periods, is likely a contributing factor to the tendency of AMS farms to use more injectable antimicrobial protocols in treating mastitis (Deng et al., 2020).

Systemic administration of antimicrobials for localised infections such as IMI has potential to increase risk of antimicrobial resistance in bacterial populations. There are also questions as to the efficacy of various injectable protocols, with few products licensed specifically for treatment of intramammary infection. This topic merits further research but, as always, the goal must be to reduce IMI incidence to minimise the requirement for treatment.

CONCLUSIONS

Automatic milking systems have numerous specific areas of risk for IMI that are additional to the general risk factors found in conventional systems. Whilst inherent to the system, these challenges do not make poor udder health performance inevitable. If all stakeholders in AMS systems acknowledge the presence of these risk factors, and work to understand them, interventions can be put in place to mitigate the impact on udder health.

Whilst it is sensible for the industry to accept that good udder health performance is more difficult to achieve in AMS than CMS, this must not be used as an excuse for IMI and milk quality parameters to be outside of conventional targets. Solutions exist to eliminate, reduce, or counteract all of the specific AMS risk factors for IMI. Identifying which risk factors are present on each individual AMS farm allows bespoke interventions to maintain performance well within acceptable levels for cow health and welfare and business profitability.

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USING THE 'QUARTERPRO' MASTITIS CONTROL SCHEME IN PRACTICE: OVERVIEW AND HERD EXAMPLES

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SUMMARY

A new national scheme for mastitis control in the UK ("QuarterPRO") was launched by AHDB Dairy in conjunction with University of Nottingham and QMMS Ltd. in February 2020, with the aim of providing an accessible route to control and prevention of mastitis on farm. The QuarterPRO scheme incorporates rapid analysis of data with provision of research-led resource material that is freely available and importantly, the control scheme is built on the under-pinning research and evidence base behind the highly successful Dairy Mastitis Control Plan, both in the use of data analysis and interventions. Farmers, veterinary surgeons and advisors are able to use novel and bespoke software to convert and present a dairy herd's milk recording and clinical mastitis data such that the predominant "pattern" of mastitis on farm is shown, *i.e.* one of predominantly contagious mastitis infection patterns, environmental lactating period origin infections or environmental dry period origin infections. Having used this Pattern Analysis Tool, the appropriate mastitis pattern resource material is consulted for ideas on those control measures that are likely to be important to put forward in discussion with the client. Finally, the QuarterPRO scheme encourages this process to be repeated every three months (*i.e.* quarterly), such that mastitis control is based on a prediction of the main mastitis ***P****attern,* vets and advisors react using the appropriate ***R****esource* material, and this helps optimise the control of mastitis in an ***O****ngoing* manner. This paper discusses aspects of the QuarterPRO scheme from a practical standpoint, and presents some examples to illustrate the scheme.

INTRODUCTION

The control of mastitis remains a focus of attention for dairy farmers, veterinary surgeons and advisors due to its impact on cow health and welfare, milk quality and milk production, and the financial costs associated with treatment, prevention and ongoing control. In addition, the focus on the unnecessary use of antibiotics in agriculture has meant that mastitis control in dairy herds has received a lot of interest, particularly around prevention of new infections and alternative treatment strategies. Whilst the latter has been in the spotlight in the last 10 years, particularly the selective use of intramammary antibiotic for infected cows at drying-off and the selection of intramammary antibiotic treatment for clinical mastitis based on culture results, the long term reduction and rationalisation of antibiotic use in mastitis control is achieved through improved management to prevent new infections. This mantra of “avoid the need to treat mastitis” comes through greater understanding of the predominant “pattern” of infection in the herd and targeted implementation of well-specified interventions to reduce the rate of new infection, either in lactation or during the dry period. For most dairy herds, environmental mastitis pathogens predominate, and therefore management of housed and pastured environments is a key component of mastitis control and many interventions will be focussed in these areas.

BACKGROUND TO THE DEVELOPMENT OF ‘QUARTERPRO’

The development of the original AHDB Dairy Mastitis Control Plan (DMCP) followed the publication in 2007 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 (3). 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. After this 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 have been calculated at approximately £40 per cow in herd per year, after costs of implementation have been deducted (1). This approach has continued to be recognised as a “Gold Standard” route to mastitis control by the industry, milk buyers and retailers.

However, the DMCP approach is often perceived to be onerous, especially for herds that are not perceived to have a severe “mastitis problem”. The DMCP requires two days of training and is therefore not widely available to farmers, veterinary surgeons or dairy herd advisors. There has even been concern that the DMCP may be negatively perceived by the industry as a “last resort” for herds where mastitis control is particularly poor. Therefore, a gap in mastitis control was identified, with **a perceived need for an “entry-level” approach which would be widely beneficial and cost effective for many farms, and**

which could improve udder health or milk quality even in the absence of an apparent mastitis 'problem'. This QuarterPRO scheme has been made available to all, requiring only a basic accreditation process for those veterinary surgeons and advisors wishing to become recognised deliverers, similar to other industry control schemes for Johnes Disease and BVD.

OVERVIEW OF THE 'QUARTERPRO' SCHEME

The QuarterPRO scheme follows the same three-step process as the DMCP, namely a data analysis step, selection of those management interventions that are likely to be beneficial and continued follow up and close monitoring of data to ensure compliance. More detail on the QuarterPRO process is outlined below and summarised in Figure 1.

Figure 1: Schematic to illustrate the QuarterPRO three-step process

QuarterPRO Step 1: Predict the pattern

The biggest, and commonly misunderstood, challenge associated with mastitis control is understanding the origin of intramammary infections. The relative importance of dry period origin and lactating period origin infections, as well as environmental sources of infection versus contagious transmission between cows and seasonal effects may be defined as the herd mastitis "pattern". The first step of the QuarterPRO approach automates this mastitis data analysis process through development and validation of an automated "pattern analysis tool" that indicates the relative importance of the above factors in mastitis epidemiology on an individual farm (2). This Pattern Analysis tool is freely available online (see https://ahdb.org.uk/mastitis-pattern-analysis-tool) and accepts data converted from milk recording files. The sequence of steps is summarised below:

- User accesses farm milk recording data in Common Data Layer (CDL) format
- CDL data is converted to a format required for analysis using software that is free at point of use (CDL Data Converter; ©QMMS Ltd and SUM-IT Computer Systems)
- Clinical mastitis event data can be merged alongside this converted data using CSV format if this data is not already reported to the milk recording organisation
- An output file is generated containing 18 months of individual cow somatic cell count (SCC) data and clinical mastitis event data
- This output file is then imported into the herd mastitis Pattern Analysis Tool and an automated assessment given for the predominant *current* mastitis pattern (*i.e.* for the last three months) and the predominant *recent* mastitis pattern (*i.e.* for the last 12 months), as shown in the example in Figure 2.

Having identified the predominant mastitis infection pattern (*e.g.* mainly environmental mastitis infections of predominantly lactating period origin), the user is now in a position to better advise the farm on those control measures that are better able to reduce new infections. For example, having identified an environmental lactating period origin pattern, any advice around disinfection of milking clusters between cows or improving the coverage of post-milking teat disinfection will not be as effective, as these control measures are aimed at reducing transmission of contagious mastitis between cows.

Whilst the pattern analysis tool aims to provide suitable direction to the user, it is clearly dependant on adequate data being available for analysis. For those herds without individual cow SCC data or for those herds that do not report clinical mastitis events, a predominant mastitis pattern cannot be arrived at. This precludes *automated* use of the pattern analysis tool, but the pattern tool may still be used for manual entry of that data which may be available, for example bulk SCC results and clinical mastitis events in cows less than 30 days in milk.

Figure 2: Example output from the mastitis Pattern Analysis Tool

QuarterPRO Step 2: React using resources

Once the pattern analysis tool has directed the QuarterPRO user towards the predominant mastitis infection pattern, easy-to-use resource material has been produced to accompany each pattern, namely:

- Environmental infections of predominantly lactating period origin (see https://ahdb.org.uk/knowledge-library/control-of-environmental-mastitis-in-lactation)
- Environmental infections of predominantly dry period origin (see https://ahdb.org.uk/knowledge-library/dry-cow-management-a-practical-guide-to-effective-mastitis-control)
- Contagious mastitis infection (see https://ahdb.org.uk/knowledge-library/control-of-contagious-mastitis)
- In addition, there is also resource material produced to accompany those herds where there is also a significant infection pressure from first lactation heifers at calving (see https://ahdb.org.uk/knowledge-library/control-of-heifer-mastitis)

The aim of these handy resource booklets and factsheets is to direct the veterinary surgeon and advisor towards those evidence-based interventions, many of which came out of the original DMCP. However, an important difference between the QuarterPRO scheme and the DMCP is the latter provides a structured and detailed approach to the selection of management interventions, whereas QuarterPRO simply provides ideas for discussion points given the predominant mastitis pattern – it is then up to the veterinary surgeon or herd advisor to provide a suitable framework and appropriate action list. The veterinary surgeon and herd advisor are encouraged to sit down with the farm client and go through ways to implement these actions, rather than simply hand over the resource material and expect farmers to implement changes without any direction or comment.

QuarterPRO Step 3: Optimise ongoing mastitis control

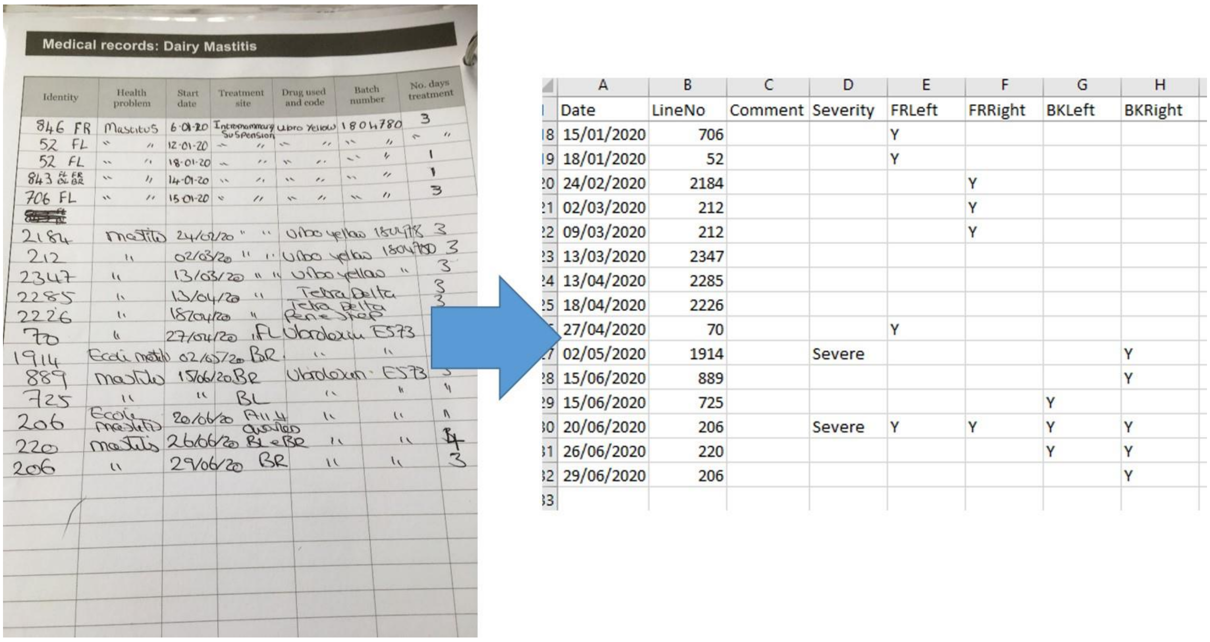
Perhaps the most important element of any herd health work, and the third stage of the QuarterPRO scheme, is the ongoing monitoring of the pattern and discussion of agreed actions and regular encouragement. The veterinary surgeon and advisor is encouraged to do this quarterly, and repeat step one to monitor the predominant pattern and see if it may have changed in response to any interventions that have been put in place, and repeat step two to review those interventions and discuss what else may be appropriate.

EXAMPLES: USING QUARTERPRO WITH YOUR HERDS

Collating clinical mastitis data

Of particular importance when using QuarterPRO in practice is how to support those herds that may be full milk recording, but who do not share clinical mastitis event data with their milk recording organisation. The practice therefore must have some method of capturing basic clinical mastitis event details, namely cow ID and date of the case (whether antibiotic treatment was given or not). This can be kept for herds using a simple spreadsheet template, with farmers encouraged to share this data with members of the practice administration staff or the veterinary advisor or consultant themselves (Figure 3). This means that every three months, the spreadsheet is updated and used alongside the CDL Converter tool to produce the output file required for pattern analysis.

For those herds using on-farm software, a list of clinical mastitis cases can be exported in *.CSV format and simply copied into the spreadsheet template. Alternatively, for those veterinary surgeons and herd advisors who are using the TotalVet analysis software (©QMMS Ltd and SUM-IT Computer Systems), a back-up taken from software packages such as UNIFORM Agri, Interherd, SUM-IT Total Dairy and DairyPlan C21 can be imported into TotalVet, and the output file required for use with the Pattern Analysis Tool generated from within the TotalVet software.



Date	LineNo	Comment	Severity	FRLeft	FRRight	BKLeft	BKRight
15/01/2020	706			Y			
18/01/2020	52			Y			
24/02/2020	2184				Y		
02/03/2020	212				Y		
09/03/2020	212				Y		
13/03/2020	2347						
13/04/2020	2285						
18/04/2020	2226						
27/04/2020	70			Y			
02/05/2020	1914		Severe				Y
15/06/2020	889						Y
15/06/2020	725					Y	
20/06/2020	206		Severe	Y	Y	Y	Y
26/06/2020	220					Y	Y
29/06/2020	206						Y

Figure 3: Collating clinical mastitis events

All year round calving herds

The approach to using QuarterPRO with all year round calving herds is relatively straight forward, although the veterinary surgeon or herd advisor should ensure that three month periods of analysis cover management events such as turnout, housing and the impact of summer temperatures in June, July and August when creating the output file to use with the mastitis Pattern Analysis Tool.

A recent example of an all year round herd with a predominantly **environmental mastitis pattern of lactating period origin** ('EL') is summarised in Table 1. Suggested interventions focussed on management of the *early* lactation group only (cows less than 120 days in milk), with the following actions suggested:

- Bedding frequency increased to three times daily in early lactation
- Open up outside area to increase available "living space" per cow (4)
- Review methods to control heat stress, including painting out skylights in the cubicle house (Figure 4)
- Consideration given to trialling a deep bed using sand for this early lactation group

Table 1: Summary of QuarterPRO scheme for Herd B

Parameter	**Herd B**
Herd size	550 cows
Calving pattern	All year round
Milk production	11,000 litres, milked three times daily
Somatic cell count	140,000 cells/ml (rolling 12-month average)
Clinical mastitis rate	60 cases per 100 cows/year (rolling 12-month average)
Housing and feeding	Total confinement housing, mattress cubicles with sawdust (lactating cows), cubicles and loose yards (dry and calving cows)
Milk recording CDL file	Yes (National Milk Records)
Clinical mastitis events	Yes (DairyPlan C21)
Pattern Analysis Tool	Environmental Lactation ('EL') pattern

Block calving herds

The approach to using QuarterPRO with block calving herds requires a bit more thought as to the three month periods of analysis, to ensure that the main calving period (and therefore any impact of dry period origin infection) is including in the appropriate quarter. For example, for spring block calving herds this means one of the three month periods may be February, March and April and for autumn calving herds we would generally wish to include August, September and October as a discrete three month block when creating the output file to use with the mastitis Pattern Analysis Tool.

A recent example of an autumn block calving herd with a predominantly **environmental mastitis pattern of dry period origin** ('EDP') is summarised in Table 2. Suggested interventions focussed on management of the *close to calving* group (cows in the last three weeks of the dry period), with the following actions suggested:

- Late dry period cows moved into empty lactating cow cubicle accommodation, bedded daily with sawdust and moved across to calving yard within 24-48 hours of expected calving date
- Calving cows managed in the loose yard bedded with straw at a stocking rate of $12m^2$ per cow to a maximum of 25 cows allowed on the yard at any one time

- New clean straw added daily, yard completely cleaned out every two weeks
- Additional loafing space made available using outside yard (Figure 5)

Table 2: Summary of QuarterPRO scheme for Herd W

Parameter	**Herd W**
Herd size	250 cows
Calving pattern	Autumn block
Milk production	9,000 litres, milked twice times daily
Somatic cell count	130,000 cells/ml (rolling 12-month average)
Clinical mastitis rate	36 cases per 100 cows/year (rolling 12-month average)
Housing and feeding	Seasonally pastured (lactating and dry cows), winter housing of mattress cubicles with sawdust (lactating cows), loose yard (close to calving and calving cows)
Milk recording CDL file	Yes (National Milk Records)
Clinical mastitis events	Yes (UNIFORM Agri)
Pattern Analysis Tool	Environmental Dry Period ('EDP') pattern

Figure 4: Lactating cow environment (Herd B)

Figure 5: Dry cow outside loafing area (Herd W)

CONCLUSIONS

The QuarterPRO scheme offers an exciting and very easy to use approach for farmers, veterinary surgeons and advisors to rapidly review mastitis and SCC data in such a way as to give confidence in the likely areas of advice that are required. In addition, the publication of up to date resource material should give guidance to veterinary surgeons and advisors and avoid the possibility of inappropriate advice being given, and instead ensure targeted advice on those management areas that are likely to have an impact. The QuarterPRO scheme provides the structure and framework for more detailed mastitis "investigation", particularly when used in combination with the DMCP, whereby the Mastitis Control Plan software may be used to capture current management practices and therefore indicate which may be deficient, given the current pattern of mastitis on farm.

ACKNOWLEDGEMENTS

The author wishes to acknowledge the work of the Mastitis Control Plan and QuarterPRO group, particularly Prof. Andrew Bradley MRCVS and Prof. Martin Green MRCVS, Dr Katharine Leach, Dr Chris Hudson MRCVS, and Dr Pete Down MRCVS. Grateful acknowledgement is also extended to AHDB Dairy, in particular Derek Armstrong MRCVS, Dr Jenny Gibbons, Helen Brookes, James Hague and Kate Smith.

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Proceedings of the British Mastitis Conference (2020) Sixways, Worcester, p 53 - 54
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UDDER HEALTH PARAMETERS FROM UK SENTINEL HERDS FOR 2019

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The AHDB Dairy Sentinel Herds project aims to monitor trends in clinical and subclinical mastitis over time. In 2016, 118 Sentinel Herds reflecting the geographical distribution of dairy farms in England, Wales and Scotland, were recruited with the criteria of 1) reliable electronic recording of clinical mastitis and 2) preferably monthly Individual Cow Somatic Cell Count recording. An additional six herds were recruited in 2017, to maintain numbers in case of 'wastage'. Participating farms provide data on clinical mastitis cases, and milk recording information, in electronic format. Data are "cleaned" to remove implausible values, using standardised thresholds, resulting in different numbers of observations for individual parameters. Key udder health parameters have been calculated annually for the years 2012 - 2019 using TotalVet software (www.total-vet.co.uk). The AHDB Mastitis Pattern Analysis Tool http://dairy.ahdb.org.uk/mastitis-pattern-tool was used to detect the predominant pattern of origin of new cases of mastitis (Environmental Lactation, Environmental Dry Period, or Contagious) for each herd each year.

Key results for 2019 are summarised in Table 1, for the 105 farms with robust data sets for both 2018 and 2019. Since distributions for all parameters were left skewed, data for 2018 and 2019 were compared using the Wilcoxon signed-rank test. No significant changes in median values (P <0.05) were observed. A lower percentage of herds demonstrated an improvement over the past year than was the case between 2017 and 2018, with the exceptions of the cell count parameters "% cows infected" (for which the proportion improving remained at 54%), and "% >200,000 cells/ml" (55% improved compared with 51% between 2017 and 2018).

Environmental patterns of lactation origin predominated in 53% of herds and environmental patterns of dry period origin in 14%, while in 23% of herds, lactation and dry period environment were of equal importance. As in previous years, contagious patterns appeared as a small minority, in 1.2% of herds as the predominant pattern, and in 7.5% at equal importance with environmental patterns. Intramammary infections in heifers were identified as being of high importance in 38% of herds, and moderate importance in 48%, most frequently in herds with predominantly environmental lactation patterns.

The Sentinel Herds continue to provide a valuable insight into udder health trends in the UK.
Table 1 Key farm indices and udder health indicators 2019 for farms with 2018 and 2019 data

Variable	N	Mean	Median	SE mean	Min	Max	% herds improving since 2018 (2017 - 2018 in brackets)
Herd size	105	335	273	26.3	60	1684	
Mean annual rolling 305 day yield (l)	101	8741	8791	188	4277	12775	
Calculated bulk milk SCC (,000/ml)	102	164	153	6.8	63	439	47 (54)
Clinical mastitis (CM) rate (cows affected /100 cows/ year)	105	29.3	26.0	1.7	3	97	53 (61)
Dry period origin CM rate (cows in 12)	105	0.6	0.6	0.0	0.0	2.47	59 (60)
Lactation origin CM rate (cows in 12)	105	1.9	1.8	0.6	0.26	4.95	50 (61)
Lactation new infection rate (%)	103	6.7	6.2	0.3	2.3	17.0	47 (58)
Dry period new infection rate (%)	99	15.6	13.8	0.6	4.1	36.1	53 (46)
Fresh calver infection rate (%)	99	18.8	16.8	0.8	6.5	46.2	34 (47)
% chronically infected	103	8.8	7.9	0.5	1.8	33.3	54 (54)
% > 200,000 cells/ml	103	15.8	14.9	0.6	5.5	44.6	55 (51)

ACKNOWLEDGEMENTS

The Sentinel Herds project is funded by AHDB Dairy as part of the AHDB Dairy Research Partnership. The authors would like to thank all farmers who contributed data for analysis.

Proceedings of the British Mastitis Conference (2020) Sixways, Worcester, p 55 - 56
The Dairy Group, The University of Nottingham, QMMS and BCVA

UK DAIRY FARMERS' ENTHUSIASM FOR THE QUARTERPRO UDDER HEALTH INITIATIVE

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The QuarterPRO approach to ongoing udder health improvement, recently launched by AHDB, is easily accessible to all dairy farmers with milk recording data and clinical mastitis records. It involves three steps: 1) analysis of records, using an automated "Mastitis Pattern Analysis Tool" (MPAT), which categorises the epidemiological pattern as Environmental Dry Period, Environmental Lactation or Contagious; 2) deciding on the most relevant interventions and 3) implementing changes. These steps can be presented as: Predicting the epidemiological "pattern" of mastitis for a herd, Reacting using pattern specific resources to identify relevant management changes, and Optimising ongoing mastitis control by implementing a specific action plan and reviewing records on a quarterly basis, hence the name "QuarterPRO".

The QuarterPRO initiative was launched by AHDB in Spring 2020. A series of 24 farmer workshops were attended by a total of 335 delegates. The original schedule was for 20 workshops, and popular demand led to a further four being organised. Sixteen workshops were held in England, three in Wales and five in Scotland. A sixth Scottish workshop was cancelled due to the Coronavirus COVID-19 outbreak. Registrations were received from 408 individuals, representing 277 farms and 12 other related businesses. Attendance rate was 82% of registrations. In addition, five separate workshops were held for vets and advisers, with a total of 53 attendees.

Farmers were invited to provide their herd mastitis data in advance, preferably in CDL (common data layer) format from a milk recording organisation (subject to appropriate GDPR procedures). Where data quality allowed, a herd mastitis "pattern" report was produced for each attendee. Where full milk recording data was not available, or clinical data was of poor quality, or lacking, manual calculations were made when possible, to give a suggestion of the relative importance of new infections from the dry period, and lactation. Individual farm reports were presented to the farmers, with discussion around data quality and the value of good recording. Farmers separated into groups according to their predominant herd mastitis pattern (environmental dry period, environmental lactation, or contagious) and discussed possible control measures relevant to their specific pattern, and feasible for their respective herds. Discussions were clearly animated and focussed, with good participation and exchange of ideas. Feedback from the groups was co-ordinated by the group facilitator. Each farmer left the meeting with the appropriate resource booklet for their pattern. Veterinary/ adviser workshops ran on similar lines, with the addition that delegates were encouraged to bring their own data, and shown how to analyse this using the MPAT.

Feedback from all the workshops was very positive, especially the fact that the information was “specific” and “tailored to our individual circumstances”. Relevance to the business was rated as “Good” by 44% and “Excellent” by 52% of farmers. Fifty-six percent went home “definitely” resolving to “do something with the information learned”, and 35% were “likely” to do so. Farmers recorded very specific practical areas to attend to, e.g. “increase loafing area from cubicles”, “drying off procedures”, “pre-milking routine”.

The success of these launch workshops suggests that the QuarterPRO approach should be popular with a wider group of farmers, and would encourage use of existing farm data, and improvement of mastitis records. As a result, more relevant, farm specific mastitis control actions are likely to be taken. The cyclical nature of the approach fosters regular review and ongoing improvement would be expected.

Training videos to guide advisers and farmers through the QuarterPRO process, and the tools and resources required, are available at the QPRO website https://ahdb.org.uk/quarterpro. Accreditation for veterinary surgeons providing support for the QuarterPRO process will soon be available through BCVA, in a similar way to the National Johne’s Management Plan and Register of Mobility Scorers. As a ‘next step’, or for more detailed investigations, farmers should still be signposted towards the AHDB Mastitis Control Plan, recognised as the gold standard approach to improving udder health across the UK dairy industry.

Ending with the words of two participating farmers:
(QuarterPro) “identified our source of mastitis, gave us tools to monitor and information on how to combat it”.

"A small amount of time inputting data gets results to enable you to better your herd health".

ACKNOWLEDGEMENTS

The QuarterPRO initiative is funded by AHDB Dairy as part of the AHDB Dairy Research Partnership.

Proceedings of the British Mastitis Conference (2020) Sixways, Worcester, p 57 - 58
The Dairy Group, The University of Nottingham, QMMS and BCVA

ANTIMICROBIAL SENSITIVITY OF UK ISOLATES OF KEY MASTITIS PATHOGENS.

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INTRODUCTION

Prudent use of antimicrobials dictates that sensitivity testing of target organisms should be undertaken to facilitate the selection of appropriate drugs for treatment. Whilst the broth microdilution method is accepted as the gold standard for determining antimicrobial susceptibility, the disc diffusion method is widely used in practice, albeit that interpretation needs to be in the light of the limitation of this technique. Interpretation of disc diffusion results is further hampered by the lack of robust breakpoints for bovine milk (as determined by zone sizes) when determining which isolates are likely to be susceptible and resistant *in vivo*. Despite these limitations, useful information about likely susceptibility can be gleaned from distributions of zone sizes (and indirectly Minimum Inhibitory Concentrations (MICs)). This abstract summarises the findings of a survey of mastitis isolates recently collected from across the UK.

MATERIALS AND METHODS

Isolates were collated from clinical submissions to the laboratory in early 2020. One hundred isolates each of *Escherichia coli*, *Staphylococcus aureus* and *Streptococcus uberis* and fifty isolates of *Streptococcus dysgalactiae* were collected, with no more than one of each species of each organism collected from any given farm. The species of each isolate was confirmed using MALDI-ToF at the time of collection and again prior to testing.

Isolate sensitivity was determined using the Kirby-Bauer disc diffusion method. Zone sizes were measured, and isolates were deemed to be susceptible, intermediate, or resistant based on available breakpoints, collated from a variety of sources including those published by CLSI, EUCAST and BSAC as well as those in the literature.

RESULTS AND DISCUSSION

The results of sensitivity testing are summarised in Table 1. As defined by the breakpoints used in this study, relatively few of the isolates were categorised as resistant. Fifty percent of *E. coli* and 74% of *S. aureus* isolates were considered susceptible to all the antimicrobials and antimicrobial combinations tested. Only 5% of *S. aureus* and *E. coli* isolates were multi-drug resistant, exhibiting resistance to >5 or >6 of the tested antimicrobials or combinations, respectively. Most resistant isolates were resistant to only one antimicrobial/antimicrobial class.

Amongst the Gram-positive species there was little or no resistance to non HP-CIAs, suggesting that first line treatments are appropriate in the majority of mastitis cases.

Table 1 A summary of the proportion of isolates considered to be resistant based on available breakpoints (%)

Pathogen	***E. coli***	***S. aureus***	***S. uberis***	***S. dysgalactiae***
n	100	100	100	50
Antimicrobial				
Amoxicillin/Clavulanic Acid	11	1	0	0
Ampicillin	13	2	1	2
Cefquinome*	2	0	0	0
Cefalonium	0	0	0	0
Cefalexin	10	0	1	0
Cefapirin	32	0	0	0
Cefoperazone*	3	0	1	0
Cloxacillin	-	2	50	10
Neomycin	5	3	-	-
Penicillin	-	14	0	0
Streptomycin	10	3	-	-
Sulpha/Trim	7	2	98	8
Tetracycline	12	2	16	88
Tylosin	-	3	14	6
Novobiocin	-	2	-	-
Enrofloxacin*	3	0	0	0
Ubrostar (Penicillin/Framycetin)	7	3	4	0
Ubrolexin (Cefalexin/Kanamycin)	8	0	1	2
Albiotic (Lincomycin/Neomycin)	5	0	28	6

*Critically important antimicrobials (HP-CIAs)

Our findings are broadly in line with those published in the most recent Veterinary Antimicrobial Resistance and Sales Surveillance Report (2018) (Veterinary Medicines Directorate), though penicillin and ampicillin resistance appear to be less prevalent amongst *S. aureus* isolates.

The apparent resistance to cloxacillin (oxacillin) in 50% of *S. uberis* isolates is worthy of note; however, this finding should be interpreted with care as it may reflect the breakpoints used and the bimodal distribution of MICs reported for cloxacillin in this species.

ACKNOWLEDGEMENTS
The authors gratefully acknowledge the financial support provided by MSD Animal Health for this study.

NOTES

NOTES

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FIELD EVALUATION OF THE EFFICACY OF INTRAMUSCULAR INJECTIONS OF PENETHAMATE (PERMACYL®) FOR THE TREATMENT OF CLINICAL MASTITIS IN LACTATING DAIRY COWS IN ASSOCIATION OR NOT WITH AN INTRAMAMMARY SUSPENSION OF CEFALEXIN + KANAMYCIN (UBROLEXIN®)

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INTRODUCTION

The aim of this study was to compare the efficacy of a penethamate suspension in association or not with an intramammary suspension of cefalexin + kanamycin in cows suffering from clinical mastitis.

MATERIALS & METHODS

To be enrolled cows had to present clinical signs of mastitis in one quarter only and not require additional treatment (e.g. fluids, NSAID, etc) other than those investigated in the study. A total of 150 cows from 16 Italian farms were enrolled and randomized (76 cows in the Permacyl® group and 74 in the Permacyl® + Ubrolexin® one). Due to concomitant diseases, three cows were removed from the efficacy analysis (1 in the Permacyl® group and 2 in the Permacyl® + Ubrolexin® one). The study was blinded; with an administrator, not involved in clinical assessments who dispensed all drugs. Table 1 presents a summary of the study events. Groups were homogenous at inclusion.

Table 1: Table of events

	D0	D1	D2	D3	D4	D7	D14	D28	D56	D84
Clinical exam	X	X	X	X	X	(X)	X	X	X	X
Milk bacteriology	X			X	X		X	X	X	X
Somatic cell count	X							X	X	X
Permacyl® adm.	X	X	X	(X)						
Ubrolexin® adm.	X	X								

(X) Not mandatory (i.e. at the investigator's discretion)

RESULTS

Main efficacy results were very similar between treatment groups for both bacteriological and clinical endpoints and are summarized in the following figures (Figures 1, 2 & 3). Differences were never statistically significant between groups.

CONCLUSION

The conclusion of this study is that intramuscular administration of Permacyl® alone or combined with local application of Ubrolexin® is safe and efficacious for the treatment of clinical mastitis in lactating dairy cows.

Figure 1: Clinical results (cure rate on D14, relapse rate and cure on D14 without Gram negative bacteria)

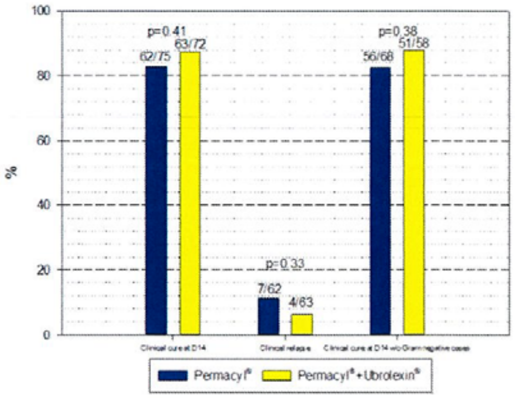


Figure 2: Bacteriological results (cure rate on D14, relapse rate, new intramammary infection)

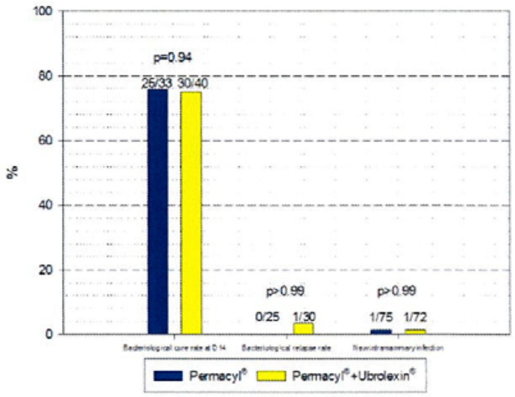
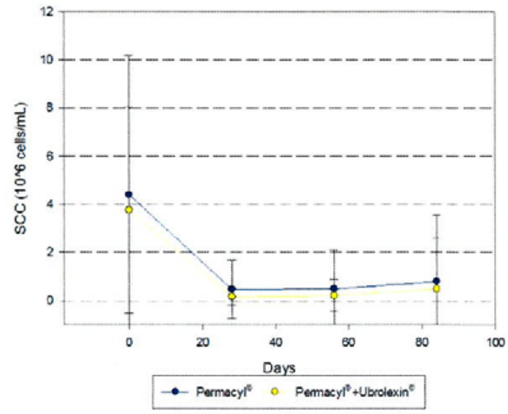


Figure 3: Time course of Somatic Cell Counts (SCC) from D0 to D84



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High SCC are not always a consequence of intramammary infections

M^cConochie, H.R., Gomez, A

ZINPRO PERFORMANCE MINERALS®

INTRODUCTION

In most cases high somatic cell counts (SCC) are associated with microbial infections of the mammary gland. However, there is evidence to suggest instances where an increase in SCC is not directly related to the presence of a pathogen. For example, the summer rise in SCC. Recently Horst *et al.*, (2019) reported that a lipopolysaccharide (LPS) challenge given intravenously to lactating Holstein dairy cows was able to elicit a significant increase in milk SCC, which was associated with systemic inflammation. Systemic inflammation has also been shown to be associated with obesity (Koster and Opsomer (2012) and excessive lipolysis (Contreras *et al.*, 2018). It has been demonstrated in a number of studies that an activated immune system results in the partitioning of nutrients away from the mammary gland and a consequential depression in milk production (Kvidera *et al.*,2014, Waldron *et al.*, 2004). This review discusses the possibility that preventing systemic inflammation may also help control milk SCC and maintaining milk output.

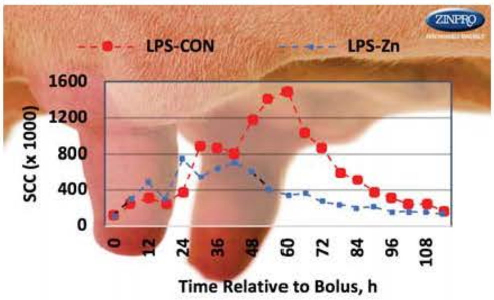

Figure 1. Effect of an intravenous LPS infusion on milk SCC

(Horst et al. 2017) Cows supplemented with a diet containing 75 mg/kg DM of Zinc Sulphate [LPS-Con], or a portion substituted by 40 mg/kg Zinc aminoacid complex [Availa®Zn].

Improving epithelial integrity can reduce the degree of inflammation

Many of the pathological conditions which are responsible for systemic inflammation are associated with morphological damage and changes in the cellular architecture of epithelial tissues. Trace mineral source has been shown to have a significant positive effect on maintaining epithelial integrity in a number of species.

Effect of pathological conditions on inflammation

A number of pathological states have been shown to increase the level of systemic inflammation in dairy cows including heat stress (Koch et al., 2019) **(Figure 2)** hind gut acidosis (Tao *et al.* 2014), lameness (Herzberg *et al.*, 2020) metritis and endometritis (Sheldon, 2016).

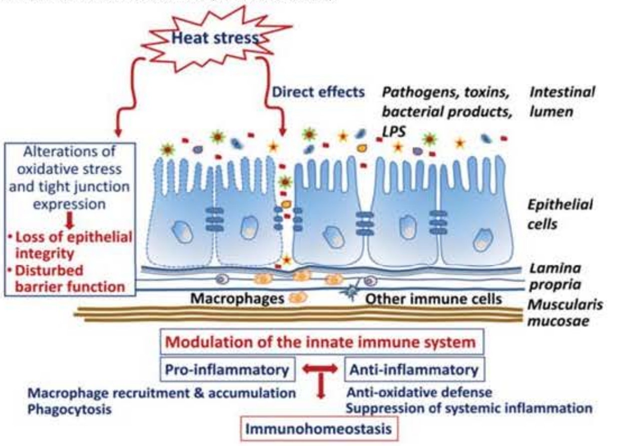

Figure 2. Effective heat stress on epithelial integrity in dairy cows (Koch *et al.*, 2019)

Trace mineral nutrition can help to control inflammation

Horst and colleagues (2019) studied the effect of zinc source on controlling inflammation induced by administration of intravenous LPS and characterised by an increase in milk SCC. Interestingly, cows fed zinc in the form of metal amino acid chelate (Availa®Zn) had lower milk SCC than cows supplemented with iso levels of zinc in the form of zinc sulphate and returned to pre challenge SCC levels earlier. This demonstrates that zinc source can also have a profound effect on the ability of the immune system to deal with inflammatory states.

Supplementing animals with metal amino acid chelate (Availa®Zn) has a positive effect on gut integrity

Heat stress and feed deprivation is known to have a negative effect on gut epithelial cell morphology. Supplementing growing pigs with 60ppm of metal amino acid chelate (Availa®Zn) instead of zinc sulphate was shown to reduce the impact of heat stress and feed restriction on gut epithelial integrity (Pearce *et al.*, 2015) **(Figure 3)** and gut intestinal morphology in steers fed 40 ppm metal amino acid chelate (Availa®Zn) (Abuajamieh *et al.*, 2016) **(Figure 4)**.

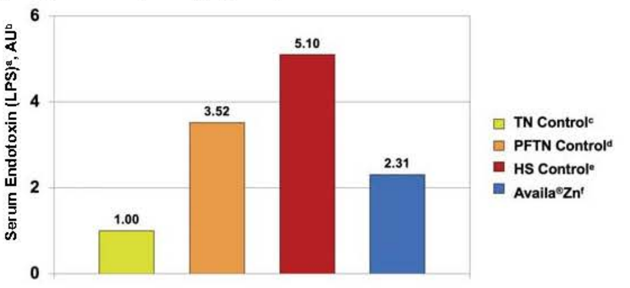

Figure 3. Effect of restricted DMI in thermal neutral conditions or heat stress on the appearance of LPS in the serum of growing pigs (Pearce *et al.*, 2015)

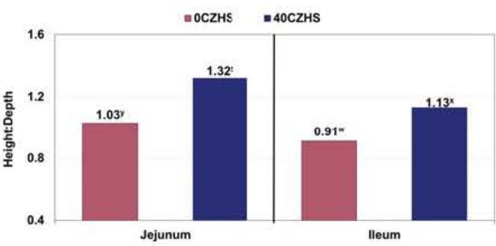

Figure 4. Effect Of Zn Source On Small Intestine villi Height: Crypt Depth Of Growing Steers Exposed To Heat Stress Conditions (Abuajamieh *et al.*, 2016)

CONCLUSIONS

Based on the evidence available it is not inconceivable that elevated SCC can be caused by inflammatory responses to insults outside of the mammary gland in tissues such as the gut epithelium and the uterus. The impact of these insults can be mitigated by effective management interventions. For example, providing balanced diets that promote a healthy gut and preventing heat stress through effective heat abatement strategies. In addition, our studies demonstrate that effective trace mineral nutrition with metal amino acid chelate (Availa®Minerals) can also have a positive effect on reducing the severity of inflammation and supporting rapid resolution of a normal inflammatory state.

UDDER HEALTH PARAMETERS FROM UK SENTINEL HERDS FOR 2019

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Purpose: The AHDB Dairy Sentinel Herds project aims to monitor trends in clinical and subclinical mastitis over time. Data from 2019 are summarised and compared with data from 2018.

Recruitment: Through connections with QMMS Ltd and University of Nottingham, plus additional veterinary practices to give a geographically representative spread.

Selection Criteria: 1) reliable electronic recording of clinical mastitis; 2) preferably monthly Individual Cow Somatic Cell Count (ICSCC) recording.

Data: Clinical mastitis cases, and milk recording information including ICSCC, submitted in electronic format. Key udder health parameters calculated using TotalVet (www.total-vet.co.uk). 'Implausible' figures were removed using specified thresholds, thus reducing n for some indicators.

The AHDB Mastitis Pattern Analysis Tool http://dairy.ahdb.org.uk/mastitis-pattern-tool was used to determine the relative importance of environmental infection patterns in lactation and the dry period, and contagious transmission, in the likely origin of udder infections for each herd, based on the clinical mastitis and SCC data. The tool also evaluated the udder health of first lactation heifers.

Table 1: Key farm indices and udder health indicators 2019

Variable	N	Min	Max	Mean	Median	2018 median	% change in median *
Herd size	105	60	1684	335	273	265	3.02
Mean annual rolling 305 day yield (l)	101	4277	12775	8741	8791	8669	1.41
Calculated bulk milk SCC (,000/ml)	102	63	439	164	153	153.5	-0.33
Clinical mastitis (CM) rate (cows affected /100 cows/ year)	105	3	97	29.3	26	25	4.00
Dry period origin CM rate (cows in 12)	105	0	2.47	0.6	0.6	0.6	0.00
Lactation origin CM rate (cows in 12)	105	0.26	4.95	1.9	1.8	1.7	5.88
Lactation new infection rate (%)	103	2.3	17	6.7	6.2	6.4	-3.13
Dry period new infection rate (%)	99	4.1	36.1	15.6	13.8	15.1	-8.61
Fresh calver infection rate (%)	99	6.5	46.2	18.8	16.8	17.4	-3.45
% chronically infected	103	1.8	33.3	8.8	7.9	8.3	-4.82
% > 200,000 cells/ml	103	5.5	44.6	15.8	14.9	14.9	0.00

*None of these changes from 2018 to 2019 were statistically significant (Wilcoxon Rank-Sum Test $p > 0.05$).

As in previous years, the majority of herds experienced environmental origin mastitis patterns, with more of these originating in lactation than in the dry period (Figure 1).

Figure 1: % of herds experiencing various mastitis patterns in 2018 and 2019. n = 80

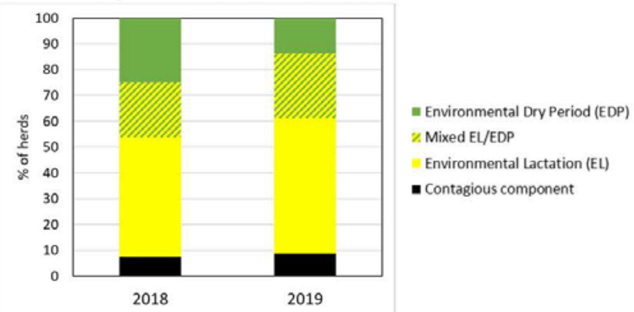
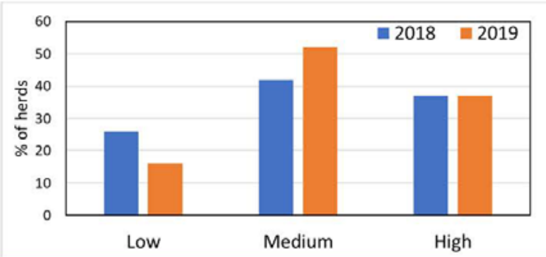


Figure 2: Importance of heifer mastitis in 105 herds in 2018 and 2019



The Mastitis Pattern Analysis Tool indicated that udder health in first lactation heifers was of considerable concern in over a third of herds (Figure 2).

Key Messages

- Between 2018 and 2019 there were no significant alterations in udder health parameters.
- The proportion of herds with contagious mastitis patterns remains very low.
- Environmental mastitis predominated in 91% of herds. In 57% of these the lactation period was most influential, while in 15% the majority of new infections occurred in the dry period. The remainder showed a mixed environmental pattern, with contributions from both lactation and the dry period.
- Udder health of heifers was of high concern in 37% of herds in both 2018 and 2019.

Acknowledgements

The work was funded by AHDB Dairy as part of the AHDB Dairy Research Partnership. We are grateful to all farmers who have allowed access to their data.

UK dairy farmers' enthusiasm for the QuarterPRO udder health initiative

James Breen, Martin Green, James Hague, Katharine Leach, Al Manning, Andrew Bradley, Janet Hartley-Byng, Derek Armstrong

What is QuarterPRO? A new initiative that aims to help farmers achieve continuous improvement in mastitis control and udder health on farm.

www. ahdb.org.uk/quarterpro

QuarterPRO - Farmer workshops Jan-Feb 2020

Locations of farmer workshops

Registrations from 277 farms

Total of 335 attendees

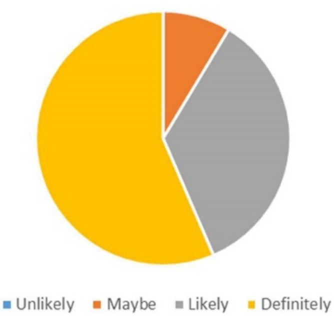
"(QuarterPro) identified our source of mastitis, gave us tools to monitor and information on how to combat it".

Indicated problems that we did not know we had. Very useful resources

"A small amount of time inputting data gets results to enable you to better your herd health".

Farmers' own data was analysed in advance using the Mastitis Pattern Analysis Tool and farmers formed groups for discussions according to their herd mastitis pattern (Environmental – Lactation – Dry period – Contagious)

Are you going to do anything with the information you have learnt?



Examples of individuals' take-home action points

Alter pre-milking routine to include pre-dip

Increase loafing area from cubicles

Improve drying-off procedures

University of Nottingham UK | CHINA | MALAYSIA

MASTITIS CONTROL PLAN

The QuarterPRO initiative is funded by AHDB as part of the AHDB Dairy Research Partnership.

QMMS

DAIRY

Applying internal teat sealants at drying off; does full versus partial insertion of the tube cannula matter?

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[2] Boehringer Ingelheim Animal Health UK Ltd

Objectives

Internal teat sealant (ITS) and intramammary antibiotic application tubes can often be used with either a short or a long insertion cannula. This study aimed to test the hypothesis that the fully inserted long cannula could increase the risk of introducing new infections into the udder leading to higher somatic cell counts (SCC) post-calving and a greater incidence of mastitis in the first 30 days post calving by comparing full insertion (FI) versus partial insertion (PI) of the cannulae in a randomised controlled trial.

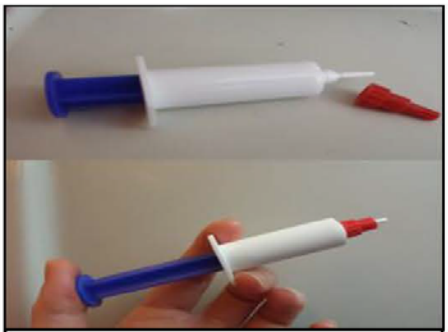

Figure 1. Full (top) versus partial (bottom) insertion cannulae.

Conclusions

This study showed that when the correct aseptic technique is used for drying cows off there is no difference in post-calving infection status or mastitis incidence when comparing FI versus PI.

Materials and methods

- Three pedigree Holstein UK dairy farms.
- The study was approved by the University of Liverpool Veterinary Research Ethics Committee.
- Cows would receive internal teat sealant only (ITS, Ubroseal® Boehringer Ingelheim Animal Health UK Ltd) or intramammary antibiotic and internal teat sealant (AB+ITS) according to farms' protocols.
- Cows were then **randomised** to receive ITS or AB+ITS via either FI or PI of the cannula/e (Figure 1).
- The facilitator was trained in best practise aseptic technique for drying-off cows by three different experts in the field.
- Monthly SCC data and incidence of mastitis within 30 days of calving collected from farm management software
- **Cure rates** (cows with SCC>200K cells/ml before drying off having a first test of SCC<200k cells/ ml after calving) and **new infection rates** (cows with SCC<200K cells/ml before drying off having a first test of SCC>200k cells/ ml after calving) were calculated.
- Univariable and multivariable regression analyses were employed for data analysis.

Results

- **287** cows were included in the study
- **135** cows received full insertion of the cannula/e
- **no difference** in post-calving SCC, new infection rates, cure rates, or mastitis incidence when comparing FI versus PI.
- with regards to cows with low SCC before drying off, cows receiving PI were 1.01 times as likely to have high SCC post calving as cows receiving FI (95% confidence interval (CI): 0.42 to 2.46, $P = 0.98$).
- Cows in their second or greater lactation and cows calving in the Spring or Summer were more likely to acquire a new infection compared to cows in their first lactation and cows calving in the Autumn respectively.
- Cows in their first lactation were 9.86 times more likely to cure an infection comparing to older cows (CI: 0.83 – 117.62, $P = 0.07$).
- PI versus FI was also not associated with the cure rate post calving (cows receiving PI were 1.45 times as likely to remain with a high SCC post calving as cows receiving FI; 95% CI: 0.30 to 7.06, P = 0.649).
- Cows in their second or greater lactation were 5.23 times more likely to be diagnosed with clinical mastitis the first month after calving comparing to cows in their first lactation (CI: 1.34-20.31, $P = 0.017$).

Acknowledgements

This study was funded by Boehringer Ingelheim Animal Health UK Ltd. The funder was involved in the study design but not in data collection and analysis. The three collaborating farms are gratefully acknowledged for their willingness to participate in the study.

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UNIVERSITY OF LIVERPOOL

BRITISH MASTITIS CONFERENCE

Boehringer Ingelheim

ANTIMICROBIAL SENSITIVITY OF UK ISOLATES OF KEY MASTITIS PATHOGENS

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- Prudent use of antimicrobials dictates that sensitivity testing of target organisms should be undertaken to facilitate the selection of appropriate drugs for treatment.
- Broth microdilution method is accepted as the gold standard for determining antimicrobial susceptibility, however, the disc diffusion method is widely used in practice, albeit that interpretation needs to be in the light of the limitation of this technique.
- Interpretation of disc diffusion results is hampered by the lack of robust breakpoints (as determined by zone sizes) for determining which isolates are likely to be susceptible and resistant *in vivo*.
- Despite its limitations, useful information about likely susceptibility can be gleaned by looking at distributions of zones sizes (and therefore indirectly Minimum Inhibitory Concentrations (MICs)).

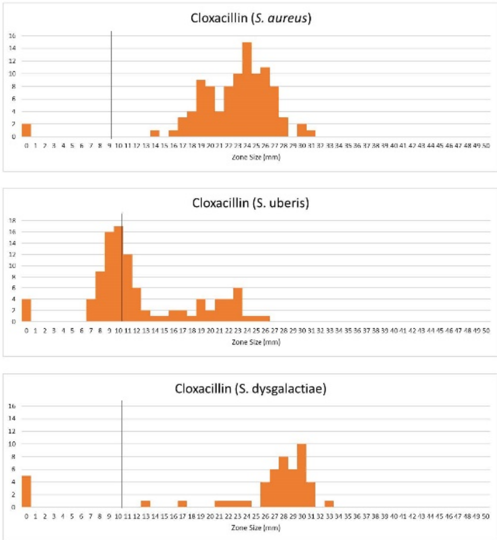
- Isolates were collated from laboratory submissions in 2020.
- Species were confirmed by MALDI-ToF.
- Susceptibility was determined using the disc diffusion method.
- Breakpoints were collated from a variety of sources including those published by CLSI, EUCAST and BSAC as well as those in the literature.

Figure 1: An illustration of the Kirby-Bauer Disc Diffusion Method

Table 1: A summary of the proportion of isolates considered to be resistant based on available breakpoints (%)

Pathogen	*E. coli*	*S. aureus*	*S. uberis*	*S. dysgalactiae*
n	100	100	100	50
Antimicrobial				
Amox/Clav Acid	11	1	0	0
Ampicillin	13	2	1	2
Cefquinome*	2	0	0	0
Cefalonium	0	0	0	0
Cefalexin	10	0	1	0
Cefapirin	32	0	0	0
Cefoperazone*	3	0	1	0
Cloxacillin	-	2	50	10
Neomycin	5	3	-	-
Penicillin	-	14	0	0
Streptomycin	10	3	-	-
Sulpha/Trim	7	2	98	8
Tetracycline	12	2	16	88
Tylosin	-	3	14	6
Novobiocin	-	2	-	-
Enrofloxacin*	3	0	0	0
Ubrostar (Penicillin/Framycetin)	7	3	4	0
Ubrolexin (Cefalexin/Kanamycin)	8	0	1	2
Albiotic (Lincomycin/Neomycin)	5	0	28	6

Figure 2: Zone size distribution for cloxacillin for Gram-positive isolates, illustrating the bimodal distribution of zone sizes amongst *Streptococcus uberis* isolates



Resistance breakpoints are illustrated by the vertical bar

***Critically important antimicrobials (HP-CIAs)**

Key Messages

- Clinical decisions related to apparent resistance need to be taken with care given the uncertainty about breakpoints for mastitis pathogens. Further work using broth microdilution is warranted.
- There was relatively little resistance amongst mastitis isolates.
- **ALL** Gram-positive isolates were susceptible to at least one first line antimicrobial.
- Resistance involving >1 antimicrobial class was rare, <5% of isolates were resistant to >5 antimicrobials.
- The bimodal distribution of MICs seen in the *S. uberis* population suggests that it may be worth understanding the microbial population on individual farms when making decisions about the use of intramammary tubes containing cloxacillin.

Acknowledgements

The authors gratefully acknowledge the financial support provided by MSD Animal Health for this study.