NZ RESEARCH UPDATE

Accuracy of somatic cell count, rapid mastitis test and electrical conductivity used alone and in combination for making dry cow therapy decisions at drying off.

The New Zealand dairy industry is currently moving towards a more targeted use of antibiotic dry cow therapy in order to minimise antimicrobial consumption. The purpose of dry cow therapy is to cure existing subclinical intramammary infections (IMI) and prevent new IMI from being established over the dry period. On farms with a low prevalence of major pathogen IMI at drying off, the main purpose of dry cow therapy has shifted from cure to prevention. Non-antibiotic internal teat sealants have been shown to be at least as effective as antimicrobial dry cow therapy at preventing new IMI over the dry period and they therefore present an opportunity to reduce antimicrobial usage.

To apply targeted antibiotic dry cow therapy, the infection status of cows must be identified. The goal is to identify as many infected cows as possible and treat them with antibiotic dry cow therapy (with or without an internal teat sealant) and minimise the number of misclassified cows that would lose an opportunity to be cured. At the same time, the number of uninfected cows that are unnecessarily treated with an antibiotic dry cow therapy should also be minimised.

The most accurate method of determining IMI status is to perform microbiology on every quarter of every cow, which is of course rarely feasible. We therefore rely on indirect tests, in particular somatic cell count (SCC) data from herd testing, which has become the industry standard. However, many farmers do not complete three or four herd tests for the season, and many do not herd test at all.

To help veterinarians challenged by incomplete information, Zoetis commissioned a pilot study that evaluated various tests used alone or in combination for determining IMI status and compared them against the gold standard of microbiology. This study, conducted by Cognosco and published in the New Zealand Veterinary Journal (Gohary and McDougall 2018), has provided clinically-relevant information on how veterinarians can make dry cow therapy decisions in the absence of regular herd testing. This research update shares some of the results from this study.

STUDY DESIGN

The objective was to evaluate the diagnostic value of the following tests used alone or in combination, using microbiology as the gold standard:

- Maximum SCC from the preceding lactation's herd tests
- SCC of only the most recent herd test
- RMT at the cow and quarter level
- Electrical conductivity at the cow and quarter level

Eligible cows were selected from three autumn-calving herds that had performed regular herd testing through the lactation. Cows were excluded if they had clinical mastitis on the day of testing or if they were systemically unwell or had been treated in the previous 14 days with antibiotics or anti-inflammatories.

Quarter milk samples were tested at drying off using RMT and an electrical conductivity meter and duplicate quarter milk samples were collected for bacteriology. RMT results were scored on a scale of 0–3, where 0=no thickening, trace=slight thickening, 1=distinct thickening but not gel formation, 2=immediate thickening followed by gel formation and 3=immediate gel formation. In addition to electrical conductivity, each quarter was assigned an inter-quarter ratio by dividing the electrical conductivity value of each quarter within a cow by the lowest quarter value obtained from within the same cow. RMT and electrical conductivity were assessed at both the quarter level and at the cow level while herd test SCC remained a cow-level variable. Cow-level RMT was calculated using two techniques: assigning the cow the highest quarter-level RMT score and by taking the number of quarters with a score ≥ trace. Cow-level electrical conductivity and inter-quarter ratio were calculated by taking the highest quarter-level result.

The tests were evaluated for the presence of IMI by any pathogen and IMI by major pathogens (*Staph. aureus, Strep. uberis, Strep. dysglactiae, Strep. agalactiae, Arcanobacterium pyogenes, yeast, Escherichia coli, Klebsiella* spp. or *Serratia* spp).

Among other assessments, the area under the receiver operator characteristic curve (AUC) was calculated for each diagnostic test. The receiver operator characteristic curve is a plot of sensitivity versus the false positive rate for several different cut points of a diagnostic test. AUC can take a value between 0 and 1, with values between 0.5 and 1.0 indicating a test that performs better than random chance and a value of 1.0 indicating a perfect test. The cut point with the maximum sum of sensitivity and specificity was used to define the optimal cut-point for each diagnostic test.

RESULTS

Analysis was conducted on data from 153 cows (609 quarters). IMI with any pathogen was found in 62/153 (40.5%) of cows and 99/609 (16.3%) of quarters, with coagulase negative staphylococci predominating. IMI with major pathogens was found in 7/153 (4.6%) of cows and 8/609 (1.3 %) of quarters.

All tests were more accurate at predicting IMI with a major pathogen than with any pathogen. There was no significant difference in overall accuracy between the last SCC, the maximum SCC of the season's herd test data and RMT at predicting IMI with a major pathogen or any pathogen (Tables 1 and 2). Electrical conductivity was numerically less accurate at the cow and quarter levels for predicting IMI with a major pathogen or any pathogen. Combining RMT or electrical conductivity with SCC in series or in parallel improved the accuracy slightly (data not shown).

INTERPRETATION

This study showed that using SCC information from only the last herd test SCC was as accurate as using the highest SCC from any herd test of the lactation. This indicates that a single herd test may be sufficient for making dry cow therapy decisions. However, veterinarians should consider how stable the herd's infection prevalence is and how close to drying off the herd test is performed. Examining the effect of the timing of the herd test was not an objective of the present study. Previous research showed that herd test data collected more than 80 days prior to drying off performed poorly for predicting infection status at drying off (McDougall and Compton 2014).

For herds that do not herd test, RMT at dry off had comparable accuracy to SCC but it requires a skilled operator who can competently and consistently grade the RMT.

Combinations of tests in parallel or series did not improve outcomes sufficiently to justify the time and/or cost.

The improved accuracy of the tests with regard to major pathogen IMI was interesting and possibly related to the more significant inflammation associated with major pathogens.

Veterinarians should interpret this study in light of its limitations and apply it according to the individual circumstances of their farms. It was a pilot study and therefore limited in scale. There were only seven cows with major pathogen infections at drying off. The optimal cut point for each test was selected based on receiver operator characteristic curves, but the ideal cut point depends on the objectives and priorities of the farmer and veterinarian and is a trade-off between minimising antimicrobial consumption and avoiding misclassification of truly infected cows. It is worth noting that 90% of major pathogen IMIs in cows that were treated with an internal teat sealant alone at drying off self-cured over the dry period (McDougall and Compton 2014).

Zoetis encourages veterinarians to read the full study report, which contains more information than presented in this summary, available at SciQuest.

Table 1: Test cut-point that optimised sensitivity (Se) and specificity (Sp), with area under the receiver operator characteristic curve (AUC), for indirect predictors of intramammary infection, at the cow (n=153) and quarter (n=595) levels, when compared to microbiological culture of any pathogen as a gold standard.

Variable	Cut-point	AUC (95% CI)	Se	Sp
Cow-level				
Last SCC[a]	≥77x103 cells/ml	0.69 (0.60-0.78)	0.57	0.79
Highest SCC[b]	≥110x103 cells/ml	0.64 (0.55-0.73)	0.63	0.64
RMT[c]	≥1 quarter	0.63 (0.54-0.71)	0.71	0.57
Max RMT[d]	score ≥trace	0.69 (0.60-0.77)	0.71	0.57
EC IQR[e]	≥1.37	0.62 (0.53-0.72)	0.39	0.85
Mean EC	≥5.5 mS/cm	0.58 (0.48-0.67)	0.47	0.70
Quarter-level				
RMT	score ≥trace	0.63 (0.58-0.68)	0.46	0.78
EC	≥5.1 mS/cm	0.57 (0.51-0.64)	0.68	0.47
EC IQR	≥1.14	0.58 (0.52-0.64)	0.48	0.66

Table 2: Test cut-point that optimised sensitivity (Se) and specificity (Sp), with area under the receiver operator characteristic curve (AUC), for indirect predictors of intramammary infection, at the cow (n=153) and quarter (n=595) levels, when compared to microbiological culture of a major pathogen as a gold standard.

Variable	Cut-point	AUC (95% CI)	Se	Sp
Cow-level				
Last SCC[a]	≥150x103 cells/ml	0.78 (0.58-0.98)	0.71	0.80
Highest SCC[b]	≥148x103 cells/ml	0.79 (0.66-0.92)	0.86	0.65
RMT[c]	≥1 quarter	0.75 (0.65-0.85)	1.00	0.49
Max RMT[d]	score ≥trace	0.83 (0.72-0.94)	1.00	0.49
EC IQR[e]	≥1.47	0.72 (0.47-0.98)	0.71	0.86
Mean EC	≥7.0 mS/cm	0.40 (0.12-0.69)	0.14	0.98
Quarter-level				
RMT	score ≥trace	0.91 (0.86-0.97)	1.00	0.75
EC	≥56.2 mS/cm	0.47 (0.17-0.76)	0.38	0.84
EC IQR	≥1.30	0.52 (0.28-0.76)	0.38	0.85

a. Somatic cell count at the last herd test of the lactation.
b. The highest SCC at any herd test of the lactation.
c. Number of quarters at or above the cut point.
d. The highest RMT score of the cow's quarters.
e. Maximum inter-quarter electrical conductivity ratio.

Gohary K, McDougall S. Predicting intramammary infection status at drying off using indirect testing of milk samples. New Zealand Veterinary Journal 66, 312-8, 2018

McDougall S, Compton CW. Internal teat sealants. NZ Milk Quality Conference, 2014