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Pathogen group-specific risk factors for intramammary infection in treated and untreated dairy heifers participating in a prepartum antimicrobial treatment trial

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ABSTRACT

Heifer mastitis is a well-known problem, with several pathogens being involved. Several generic risk factors associated with the likelihood of intramammary infections (IMI) in fresh dairy heifers have been identified before. Yet, a need exists to identify pathogen group-specific factors, as the effect of (groups of) pathogens on udder health and milk yield is different. The aim of the present study was to identify pathogen group-specific risk factors for IMI in heifers participating in a prepartum antimicrobial treatment trial, allowing us to test the hypothesis that different factors are of importance between treated and untreated control heifers as well. Data from a clinical trial in which end-term heifers were treated systemically (over 3 consecutive days) 2 wk before calving with penethamate hydriodide (n = 76) or remained untreated (n = 73), were available. Several potential risk factors at the herd, heifer, and quarter level were recorded in the first 3 d in milk. Quarters from untreated heifers supplemented with ≥4 mg of selenium/d prepartum were significantly less likely to be infected with coagulase-negative staphylococci (CNS), whereas quarters were more likely to be infected with CNS when assistance during calving was needed. Udder edema before calving significantly decreased the odds of IMI with major pathogens. In treated heifers, no factors were detected that were associated with the likelihood of CNS IMI, whereas quarters from heifers were significantly more likely to be infected with major pathogens when they were housed in the calving pen more than 1 d and when they had been in contact with the lactating cows before calving. The risk factors for IMI that were identified in treated heifers were different than those in untreated heifers, independent of the pathogen group that was considered. It looks as if prepartum treatment not only changed the likelihood of infection, but also the factors that were associated with infection. However, except for treated heifers with an IMI with major pathogens, only a small proportion of the variation could be explained in the final models. Therefore, factors other than those that were studied could explain the likelihood of infection.

Key words: heifer mastitis, prepartum antimicrobial treatment, risk factor, intramammary infection, pathogen group specific

INTRODUCTION

A high proportion of dairy heifers freshen with IMI, causing either clinical or subclinical mastitis (De Vliegher et al., 2012). Several pathogens are involved, with CNS being the most prevalent in most studies (Fox, 2009). Intramammary infections caused by major pathogens in early-lactation heifers are associated with elevated SCC in early lactation and result in milk production losses, udder health problems, and premature removal during the entire first lactation (De Vliegher et al., 2004, 2005a,b; Piepers et al., 2009, 2010), stressing the need for effective control measures. In contrast, CNS IMI in early-lactation heifers have a less pronounced effect on the heifers' future performance, making the need for prevention of IMI with CNS, at least in early-lactation heifers, not a priority, or even unwanted, as heifers with CNS IMI at calving produce more and have a lower incidence of clinical mastitis (**CM**) during their first lactation compared with noninfected heifers (Piepers et al., 2010, 2013; Pearson et al., 2013).

Several factors increasing the odds of IMI in fresh dairy heifers have been identified (e.g., McDougall et al., 2009). A 10-point program specifically focusing on the prevention and control of heifer mastitis was proposed (De Vliegher et al., 2012), but did not discriminate between mastitis pathogen types. Still, studying pathogen group-specific risk factors for IMI in early-lactation heifers allows for the development of pathogen-specific prevention and control programs.

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Farmers are often more eager to treat animals, even when this includes off-label use of antimicrobials, than to improve their herd management (McDougall et al., 2009). However, in the light of prudent drug use, and even though prepartum treatment of heifers with antimicrobials is probably the easiest way to reduce the prevalence of IMI at calving in the short term (Nickerson, 2009), preventing herd health problems, such as heifer mastitis, via nonantibiotic strategies is preferable over adopting blanket treatment protocols to reduce the risk of antibiotic residues in foodstuff (e.g., milk) and the development of antimicrobial resistance in pathogens and commensals. This needs to be stressed, as the long-term effects of prepartum antimicrobial treatment on farms suffering from heifer mastitis still remain undecided (Borm et al., 2006; Sampimon et al., 2009; Passchyn et al., 2013). Logic suggests that temporary use of antimicrobials in the control of a severe heifer mastitis problem can only be applied under strict conditions and when the etiology has been identified through culturing of milk samples, and should go along with the implementation of pathogen group-specific preventive measures at the same time to further reduce the risk for new IMI (De Vliegher et al., 2012). Still, even when antimicrobial treatment is applied in the weeks before calving, not all IMI will be cured or prevented and it is currently not known which risk factors are associated with IMI in fresh heifers treated before calving with antimicrobials. We hypothesized that risk factors for treated heifers would be different from the ones for untreated heifers.

MATERIALS AND METHODS

Herds and Animals

A clinical trial was conducted between September 2008 and June 2010 and included 229 heifers from 10 commercial, well-managed dairy herds, located in a radius of 20 km around the city of Torhout (province of West Flanders, Belgium). The trial was designed to assess both the short- and long-term effects of a systemic prepartum therapy with penethamate hydriodide on udder health and milk production (Passchyn et al., 2013).

Information on herd size, bulk milk SCC, heifer mastitis problems, and housing as well as the study design have been reported before (Passchyn et al., 2013). In short, before the actual trial was conducted, herds were first monitored by sampling the first 8 heifers per herd that calved (80 heifers in total). After the eighth heifer had calved, monitoring of a herd ended and the actual clinical trial, comprising approximately an additional 16 heifers, of which half were treated before calving and half served as untreated controls, started for this herd (Table 1). Heifers were alternately assigned by the first author based on their expected calving date; every other heifer that was expected to calve was treated with penethamate.

Table 1. Descriptive statistics of the number of herds, heifers, and quarters included in the different analyses

Data set	Total number	Average[1]	Median	Range
Untreated heifers				
Herd	10	—	—	—
Heifer	73	7	8	6–8
Quarter	292	29	32	24–32
Treated heifers				
Herd	10	—	—	—
Heifer	76	8	8	6–8
Quarter	304	30	32	24–32

[1]Average number of heifers and quarters per herd.

Composite milk samples were taken between 0 and 3 DIM for SCC measurement when no visual signs of CM were observed. Also, quarter milk samples were taken between 0 and 3 DIM for bacteriological culture both from quarters with and without signs of CM.

Sample Collection and Laboratory Analyses

Samples. All heifers were sampled by the first author once between 0 to 3 DIM (further referred to as early lactation) for bacteriological culture (5 mL; duplicate quarter milk samples), were checked for signs of CM, and sampled for determination of milk SCC if no signs were present (30 mL; samples of different quarters were combined into a composite sample using equal volumes). All milk samples were collected after disinfection of the teats and after the first streams of milk were discarded. Milk samples were immediately stored at 4°C and then transported under cooled conditions to the laboratory (Milk Control Centre Flanders, Lier, Belgium).

Bacteriological Culture. Bacteriological culture was done as previously described (Piepers et al., 2007). Briefly, 0.01 mL of milk was plated on a blood-esculin agar (Oxoid NV, Erembodegem, Belgium; 1 plate per cow) and on MacConkey agar (Oxoid NV; 1 plate per cow). All plates were incubated aerobically for 36 ± 12 h at 37 ± 1°C. A quarter was considered culture-positive when growth of ≥1 colony was detected. Samples yielding 3 or more different bacterial species were considered to be contaminated. Bacteria were identified by colony morphology and Gram staining. For gram-positive cocci, catalase tests were used to differentiate between catalase-positive staphylococci and catalase-negative cocci. Colony morphology, hemolysis patterns, and