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Invited review: Incidence, risk factors, and effects of clinical mastitis recurrence in dairy cows

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ABSTRACT

Clinical mastitis (CM) is one of the most frequent and costly diseases in dairy cows. A frustrating aspect of CM is its recurrent nature. This review was conducted to synthesize knowledge on risk of repeated cases of CM, effects of recurrent CM cases, and risk factors for CM recurrence. A systematic review methodology was used to identify articles for this narrative review. Searches were performed to identify relevant scientific literature published after 1989 in English or French from 2 databases (PubMed and CAB Abstracts) and 1 search platform (Web of Science). Fifty-seven manuscripts were selected for qualitative synthesis according to the inclusion criteria. Among the 57 manuscripts selected in this review, a description of CM recurrence, its risk factors, and effects were investigated and reported in 33, 37, and 19 selected manuscripts, respectively. Meta-analysis and meta-regression analyses were used to compute risk ratio comparing risk of CM in cows that already had 1 CM event in the current lactation with risk of CM in healthy cows. For these analyses, 9 manuscripts that reported the total number of lactations followed and the number of lactations with ≤ 1 and ≤ 2 CM cases were used. When summarizing results from studies requiring ≥ 5 d between CM events to consider a CM event as a new case, we observed no significant change in CM susceptibility following a first CM case (risk ratio: 0.99; 95% confidence interval: 0.86–1.14). However, for studies using a more liberal CM recurrence definition (i.e., only 24 h between CM events to consider new CM cases), we observed a 1.54 times greater CM risk (95% confidence interval: 1.20–1.97) for cows that already had 1 CM event in the current lactation compared with

healthy cows. The most important risk factors for CM recurrence were parity (i.e., higher risk in older cows), a higher milk production, pathogen species involved in the preceding case, and whether a bacteriological cure was observed following the preceding case. The most important effects of recurrent CM were the milk yield reduction following a recurrent CM case, which was reported to be similar to that of the first CM case, and the increased risk of culling and mortality, which were reported to surpass those of first CM cases.

Key words: dairy cow, clinical mastitis, recurrence, meta-analysis

INTRODUCTION

Clinical mastitis (CM) is one of the most frequent diseases affecting dairy cows worldwide (Barnouin et al., 1999; Ruegg, 2003; Halasa et al., 2007). The incidence rate of CM ranges from 13 to 40 cases/100 cow years in different countries and housing types (Peeler et al., 2002; McDougall et al., 2007; Bar et al., 2008b; Olde Riekerink et al., 2008; van den Borne et al., 2010).

The effect of CM was investigated in numerous studies. Negative effects include severe milk losses (Gröhn et al., 2004; Steeneveld et al., 2008; Schukken et al., 2009), decreased milk quality (Barbano et al., 2006), increased treatment costs (Bar et al., 2008b), veterinary costs, extra labor (Pérez-Cabal et al., 2009), and increased probability of death and culling of the affected dairy cows (Bar et al., 2008b; Hertl et al., 2011; Cha et al., 2013). Clinical mastitis is also the main reason for antimicrobial use on dairy farms, although antimicrobial therapy is not required in all cases of CM (Pol and Ruegg, 2007; Hill et al., 2009; Lago et al., 2011a; Saini et al., 2012). The average cost of CM was estimated at €112 to €1,006 per CM case in Finland (Heikkilä et al., 2012), US\$95 to \$211 in the United States (Cha et al., 2011), and Can\$744 in Canada (M. Aghamohammadi,

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Many studies investigated risk factors for CM as well as for CM recurrence. Parity (i.e., older cows) and the early lactation period are important risk factors for CM (Hertl et al., 2011; Elghafghuf et al., 2014). During the first 30 DIM, the incidence rate of CM was estimated to be 4.6 and 2.0 times higher than during the remaining lactation in multiparous and primiparous cows, respectively (van den Borne et al., 2010; Hammer et al., 2012). Relatively high herd SCS (Nash et al., 2000; Wolf et al., 2010; Elghafghuf et al., 2014), teat-end callosity (Neijenhuis et al., 2001; Zadoks et al., 2001), tramped teats, and milk leakage (Elbers et al., 1998) were also identified as risk factors for CM in previous studies.

A very frustrating aspect of CM is its recurrent nature. A high proportion of cows experiencing a CM event in a lactation will experience additional CM episodes during the same lactation (Schukken et al., 2010). It has been observed that cows that already experienced CM, irrespective of the pathogen involved, are more prone to develop new IMI (Zadoks et al., 2001). Recurrence of CM, however, may also be caused by persistent IMI. After an apparently resolved CM case, the IMI may persist despite resolution of the clinical signs, and subsequent CM flare-up may be observed (Döpfer et al., 1999). Some pathogens are more likely to cause recurrent CM events after a first CM episode (Döpfer et al., 1999; Bradley and Green, 2001a; Zadoks et al., 2003). For example, high CM recurrence rates were observed following *Escherichia coli* and *Streptococcus uberis* CM (Döpfer et al., 1999; Zadoks et al., 2003). Whether this is due to an increased cow susceptibility to new infection or to IMI persistency between CM cases is unclear. Furthermore, intracellular survival of *Staphylococcus aureus* can lead to subsequent CM episodes (Yancey et al., 1991). In such cases, CM recurrence is, therefore, likely to result mainly from persistence of the pathogen in the udder (Yancey et al., 1991; Wenz et al., 2005; Swinkels et al., 2013; Abureema et al., 2014).

Many studies conducted in various countries have described the incidence rate of CM and its estimated effects and risk factors; however, there are fewer reports on CM recurrence. For instance, it is still unclear whether the hazard of experiencing a second CM case is increased, maintained, or reduced when compared with the baseline CM risk. Similarly, only a few studies have investigated the effect (e.g., milk yield reduction, mortality, or culling risk) of subsequent CM cases after

a first CM case in the lactation. Finally, although various hypotheses have been proposed, the interplay of the cow, pathogen, and environment factors that lead to disease recurrence is yet unclear. A first objective of the current review was therefore to synthesize knowledge on risk of additional CM events following a first CM case using a systematic review and meta-analysis study design. Secondary objectives were to report in a narrative review format on effects of recurrent CM events and on risk factors for CM recurrence in dairy cows.

MATERIALS AND METHODS

The selected study design was a narrative review of the literature; however, we made use of the systematic review methodology for selecting articles and for the meta-analysis. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology was used as a guideline during the research process and while writing this manuscript (Moher et al., 2009).

Research Questions

Three objectives—describing the risk of CM recurrence, effects of recurrent CM events, and risk factors for CM recurrence—were pursued. These 3 objectives were described separately in the 3 following research questions:

1. What is the risk of recurrence of CM in a given lactation in dairy cows?
2. What are the effects of recurrent CM in dairy cows?
3. What are the risk factors that influence CM recurrence in dairy cows?

Literature Search and Inclusion Criteria

Two databases (CAB Abstracts and PubMed) and 1 search platform (Web of Science) were used to search for English or French original manuscripts on May 7, 2014. To ensure that the information was relevant for contemporary dairy herds, only manuscripts published after 1989 were included. A single search strategy for the 3 research questions but specific to each database was designed with the assistance of a librarian. The strategy consisted of Boolean search operators combining medical subject heading or thesaurus terms. The search terms described (1) the population of interest (dairy cows), (2) the outcome (CM), and (3) the recurrent aspect of the disease. The complete search strategies can be found in Appendix 1 of the Supplemental Files (<https://doi.org/10.3168/jds.2017-13730>).

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