Clinical Mastitis in the Postpartum Period

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Introduction

Mastitis is the economically most relevant disease in milk production (Hogeveen et al. 2019) – it is not just a disease, but rather a complex of diseases and is characterized by an ever-changing pattern of appearance, symptoms and causes; it has been called an "evolving disease" (Bradley 2002), as pathogens are able to adapt and new pathogens are constantly discovered or defined, respectively.

Despite its clear infectious nature, in which a pathogen, usually bacteria, causes an inflammation, the course of events and the consequences are multifactorial (Vliegher et al. 2018). Decades ago, the individual case of clinical mastitis caused concern and had been in focus of research (Janzen 1970). Then, most mastitis causing organisms were characterised as deriving from a relatively small group of cow-adapted bacteria like Streptococcus agalactiae and Staphylococcus aureus. Today, control programs target opportunistic bacteria from environmental sources and the changing structure of dairy production calls for constantly changing efforts in safeguarding udder health (Ruegg 2017; Zadoks und Fitzpatrick 2009).

Forms of Mastitis and its Risk-Factors

There are various forms of mastitis that are extensively described in textbooks. In recent decades, subclinical mastitis in its various forms, i.e. inflammations of the udder tissue with no visible alterations of the milk and no detectable change of the general animal health, have become the main interest in clinical research. It appears to be very common; in Dutch dairy herds, for example, roughly a third of multiparous cows appears to be affected (van den Borne et al. 2010). While this form of mastitis goes frequently underrated or even unnoticed, it nevertheless causes significant economic damage. This "stealthy intruder" (University of Maryland Extension 2023) reduces milk yield, and obviously increases somatic cell count (SCC), reducing the economic return (Gonçalves et al. 2018).

Clinical mastitis (CM) is, however, still a problem most dairy farmers face regularly. Again, clinical mastitis comes in various forms and has a major impact on productivity. Incidences between 13 up to 40 cases of CM per 100 cows per year have been reported from various production systems (Jamali et al. 2018). The cost associated with a case of CM has been calculated in various ways. It may range between US$ 95 to $US 211 per case (Cha et al. 2011) for US herds. The cost is therefore varying and dependent on various animal and farm factors. It has been repeatedly shown that cows experiencing CM are likely to be diagnosed with CM again (Schukken et al. 2010; Jamali et al. 2018) . Next to previous cases, the parity of the cow is a major risk factor: In analysis of data from more than 30.000 lactations in the US, (Hertl et al. 2011) showed that the incidence of CM in multiparous cows was twice as high as in primiparous cows with about 30% of them experiencing at least one case of CM per lactation.

Clinical Mastitis in the Transition Period

Another risk factor is stage of lactation: The transition period, i.e. the transition from dry-period to early lactation clearly has the highest risk for CM (Pyörälä 2008). The transition period is characterized by various physiological changes in which the endocrinology, the metabolism and hence the immunocompetence of an animal undergo complex changes. During this time, the predominant Negative Energy Balance may trigger a cascade of inflammatory signals, putting the animal at highest risk for CM during that time (Huszenicza et al. 2004; Sordillo 2005). This fact is illustrated nicely in an Iranian study showing a concurrence of CM with metabolic conditions like hypocalcaemia (Ghavi

Hossein-Zadeh und Ardalan 2011). Clearly, CM is not a metabolic disease by itself, but the immune system delicately interacts with the metabolism, as has been illustrated on the example of infections with Streptococcus uberis and its relationship with ketosis (Swartz et al. 2021). The relationship between body condition score and occurrence of CM was also illustrated in a British study evaluating risk-factors for CM. The study covered more than 18.000 dry-period records (Green et al. 2007). The results point to the significance of parity with multiparous cows being at higher risk for CM after calving; the udder health status of the previous lactation is another risk with cows having had at least one SCC >200.000 cells/ml in the 90 days before the animals were dried off. Other factors are management related with hygiene and animal husbandry, e.g. cows that are housed in larger, cleaner sheds experience a lower risk for CM after calving. Finally, the system of dry-cow therapy was found to be of significance. Interestingly, the researchers found that farms using a selective dry-cow therapy were at lower risk for CM after calving compared to farms using a so-called "blanket-therapy", i.e. all cows receiving an antibiotic at drying off. Obviously, the udder health at drying off and the procedure itself have a major impact on the occurrence of CM after calving: If a quarter has been affected by CM in the previous lactation, the odds of this quarter developing another case after calving are 4.2 times higher (Pantoja et al. 2009). CM in the transition period is therefore influenced by various factors, the metabolic challenge around calving being the predominant risk-factor.

Consequences of Clinical Mastitis in the Transition Period

As mentioned before, mastitis is an economically relevant and costly disease and is among the main reasons for culling cows involuntarily (Langford und Stott 2012). At the beginning of lactation, the impact is considerable as concurrent disease may negatively affect prognosis and the consequences may influence the economic result of the whole remaining lactation. Every case of CM increases the risk for an animal to be culled or die because of the CM (Hertl et al. 2011). An overview of cost incurred by CM in the first 30 days of lactation is given by (Rollin et al. 2015): Total cost of US$ 444 with most of it being structural costs (US$ 316,00). These costs are: future milk production loss (US$125), premature culling and replacement loss (US$182), and future reproductive loss (US$9). While the figures itself can merely illustrate the cost that will be considerably different from farm to farm (Halasa et al. 2007), it nevertheless clearly shows the impact of CM: It reduces productivity, it reduces the productive lifespan of an animal and it affects central farm management parameters, e.g., reproduction. As previously mentioned, CM will trigger a multitude of pathophysiologic responses that may delay the onset of oestrus after calving (Huszenicza et al. 2004; Wang et al. 2021). As CM in early lactation usually precedes first artificial insemination, its impact on reproduction is very clear: A meta-analysis showed that days to first service may be prolonged by an average of more than 13d, while an additional 20 days open can be expected for cows experiencing CM prior to insemination (Dolecheck et al. 2019). In summary, CM is a costly disease; it has the biggest impact however in early lactation.

Predicting Clinical Mastitis in Early Lactation

It appears useful to be able to predict CM in early lactation. An assessment of the individual animal's risk to develop CM would allow for preventive measures. CM can be predicted nowadays by means of sensor technology: The caption of data like movement or ruminating and the analysis can predict diseases well before they are detectable by clinical examination (Kleen und Guatteo 2023; Sahar et al. 2020). It appears useful, however, to predict the probability of CM even earlier. The dry period is crucial in the infection dynamics of mastitis, as it is both: a risk period for new infection and a time where persistent infections may be cleared (M tho Seeth et al. 2015). Lastly, during the dry period the available information on animals is limited, e.g., there is no information on milk production and SCC.

There are several ways to predict the probability of CM after calving: Any cow that has experienced high SCC or CM in the previous lactation is likely to show CM after calving again (Green et al. 2007; Pantoja et al. 2009). "Selective dry cow therapy" describes the targeted treatment of those cows with an antibiotic preparation at dry-off that have a known risk for mastitis or an existing intrammary infection.

This practice is recommended to reduce antibiotics and the definition of risk is regularly based on the udder health history of these animals. There are various options to define the risk (e.g., (Scherpenzeel et al. 2016) and it has been shown that the practice can effectively support the cure of existing infections. Internal teat sealants have likewise been found highly effective in preventing new infections during the dry period (Huxley et al. 2002; Golder et al. 2016). Another way to define the risk for CM in early lactation is the collection and analysis of biochemical data. A monitoring of metabolic parameters during the dry period has the potential to identify cows at risk before calving; the technique does, however, require blood testing of the cows (Moyes et al. 2009). In addition, a regular assessment of BCS during the lactation and especially at drying off may identify cows at risk for CM (Green et al. 2007; Berry et al. 2007). Identifying animals at risk is therefore likely a combination of production data, especially udder health data and the assessment of metabolic health risk after calving. The latter can by traditional means only be achieved with assessment of BCS and milk production data, trying to achieve a forecast of the individual animal's risk. It appears useful to have this process integrated in an algorithm combining this information (Kleen und Guatteo 2023).

Preventing Clinical Mastitis in Early Lactation

Identifying cows at risk leaves open the question what to do. Preventing CM on basis of a risk assessment falls into two parts: Individual animal and herd-oriented measures.

On the individual animal level, prevention must occur well before drying off. As repeatedly mentioned, a stable metabolism in the transition period is largely a function of stable BCS throughout. Therefore, minimizing BCS gain in late lactation and the dry period itself is pivotal to avoid metabolic diseases and CM as an attached risk. Other nutritional components, such as the provision of antioxidants (Vitamin E; Selenium) during the dry period may support a stable metabolism, possibly reducing the risk of CM after calving (Khan et al. 2022). As udder health history is an important risk factor, every available option to achieve healing of existing, subclinical infection needs to be considered, as well as prevention of re-infection, e.g., by means of an internal teat sealant (Scherpenzeel et al. 2016).
For the individual animal as for the herd, management factors like housing, hygiene and movement appear critical regarding CM prevalence (Green et al. 2007). Again, mastitis is the classic multifactorial disease that cannot be controlled by one measure alone (Vliegher et al. 2018). Therefore, next to optimizing feeding, nutritional support and treatment, every farm that is defined as being at a high risk for mastitis needs to review the management practices during the transition period. Monitoring and predicting risk is not a replacement for optimization of animal husbandry: It points to the need of it!

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