Understanding Bovine Mastitis as a Dynamic Enzootic

L. THERON ; Ch. HANZEN
Production Livestock Clinical Department | School of Veterinary Medicine, Liege | Belgium
Controlling the Fluxes of a Disease Inherent in High Level Dairy Farming through Epidemiology

1. Introduction

Health disorders in bovine herds are, in essence, multifactorial. They are based on the equilibrium among various factors. The major difficulty in managing endemias in livestock production emerges from two elements: the extreme variability of practices among farms and over time on one hand and on the other hand, the crossed impact of various factors producing the same result. A simple example will illustrate the two problems: Mastitis has epidemiological components that govern their own response to means of prevention. Because no two dairy farms ever have fifty per cent of their livestock production practices in common, the establishment of the usual means of prevention will never have the same dosable impact in each of the two farms (Bradley et al. 2007; Théron et al. 2009). Further, in view of the variability of certain practices or adjustments over time, a situation can vary while all other factors remain constant, due to a neglected invisible factor, thus diminishing the strength of the prevention argument. Each of us has known situations in which post-dipping did not generate the anticipated effects, and situations in which, after a transitory improvement linked to milking practices, the situation degrades again for a cause associated with the milking machine or feeding. The conclusion of this introduction is both simple and complex: the integrated control of mastitis is based on long-term monitoring. This monitoring is justified by the economic and societal impact of this disease. Good monitoring implies the definition of key measurable control points. The aim of this article will be to define the indicators and epidemiological objectives that enable the level of mammary health and its evolution to be defined over time.

2. Performance objectives

The clinical examination of a herd is different from a classic consultation. It entails the epidemiological analysis of the problem. An analysis is thus performed of the herd functions, that is, of the functions common to all the animals. Thus, the cleanliness rating of the animals will be the average of their individual cleanliness scores. This analysis will enable the identification of a nuance between two herds between two points in time as regards the evolution of a herd. These clinical scores, such as body condition, lesions on the teats, the digestibility of fibres, and the frequency of mastitis are our clinical signs on the population scale. They point us toward an affected farm system that should be investigated, including complementary examinations, to determine the root cause of the problem. Three characteristics of mastitis must also be understood: clinical severity, chronicity or not, recovery or not (Table I).

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Table I- Type of physiopathological behaviour over time of mammary infections compared to a CCSI threshold
Mastitis has two typical epidemiological origins: the environment and already infected mammary glands (Fig. 1); the germs associated with these two models are different. The complexity lies in the fact that most of the germs can take the form of the two models, more or less, according to their affinity. Thus, *Streptococcus uberis* is a pathogen that comes from the environment, but that can easily be transmitted from cow to cow during milking. By contrast, *Streptococcus agalactiae* originates almost exclusively in infected glands. The definition of the model will undoubtedly have an impact on the understanding of the problem and on the means of treatment and prevention.

In order to establish the indicators of mammary health, it is advisable to take an inventory of the available data:

1. Clinical cases of mastitis, their treatment and severity
2. Individual somatic cell counts (SCC, milk monitoring) associated with the level and stage of production
3. Tank milk composition
4. Available supplementary analyses (conductivity, daily SCC, California mastitis test, colorimetry, etc.)

While the second and third types of data are often accessible, the first is sometimes difficult to obtain and the availability of the last is variable. With the help of the tank milk composition, frequently recorded in our countries, one can already identify one part of the inflammatory, hygienic and nutritional factors (Rysanek, 2005). This measurement, however, always carries a bias that is linked to the animals present in the tank. The SCCs enable a more precise analysis to be made of the epidemiology and nutrition, but they are paradoxically less frequent and therefore sometimes obsolete as regards the appearance of the problem (fig. 2). However, the meticulous study of the SCCs can reveal fine variations that are harbinger of modification.

Various authors have issued their rulings on the objectives to define and the performance indicators in bovine mammary health. Thus, the rate of clinical mastitis was defined and assigned an alert threshold at 30% of clinical cases per year (Radostits et al. 1998, Seegers et al. 2011). This is defined by the total number of clinical mastitis cases divided by the number of lactations during a year. Green et al. established the systematic use of indicators derived from SCCs such as the rate of recovery at dry off, the contamination rate, etc. (Bradley et al., 2007, Green et al., 2006, Green, 2007). Finally, some teams propose the combined use of clinical mastitis cases and SCCs in order to understand the evolution of these parameters and the overall economic impact of this pathology (Théron et al., 2011; Reding et al. 2011).

A cow under 100 can be considered healthy. A cow over 300 is definitely considered infected. Healthy old cow late lactation may be over 100 and subclinical heifer may be less than 300. The virtual majority of authors agree on the limit of 200,000 cells / ml as the reference threshold for separating the healthy animals from the sick ones with the best sensitivity / specificity. Some recent publications put forward the fact that primiparous cows present very low SCCs, and that a theoretical threshold of 150,000 or 100,000 cells / ml would be more appropriate for the dynamic study of cell concentrations.

In any case, in a recent discussion group at the European Buiatric Forum conference, a group of experts in mammary health stated that the threshold chosen was of little importance in the end, provided that the same threshold is maintained from one herd to the other and that the cell count variations around the threshold are interpreted correctly. By using these primary indicators, we can define secondary indicators linked to the cure or chronicity of the infections (Table III). According to the available data we may simplify the analysis by taking into account only the cases of subclinical mastitis or only the clinical cases.
one of the key points of mastitis management is at or near calving, an environmental origin of the contaminations that arise can be suggested. I will confirm this epidemiological suspicion through a bacteriological analysis.

The other use of epidemiological indicators involves monitoring them over time (Figures 5, 6 and 7).

Example: “How is my mammary health situation evolving?” or “I’ve put my new product in place; what impact has it had?”

In our example, we can identify several problems: the rate of cure at dry off is quite good (>70%); the rate of contamination in lactation has risen (to around 17%); the rate of cure has varied greatly over the past three months (31%). The logical result is the increase in prevalence of animals with >200,000 cells/ml (30 to 35%). Apart from that, instantaneous analysis shows us a level of post-partum contamination of 18% among animals that were healthy at dry off.

We can deduce that the herd is subject to a mixed model of contamination (environmental and contagious). This may mean a germ with variable behaviour or several different germs. Some of the main problems are the high recovery and contamination rates, which mean a high dynamics of pathogen circulation. There is, therefore, proliferation of the agent in the surrounding environment or contamination during milking by contaminating actions.

In the case of our example, bacteriology enables us to identify a coagulase-negative staphylococcus in five animals with subclinical mastitis. This confirms our suspicion of a mixed model, since these germs have a mixed origin. In addition, the absence of an appropriate calving shed could prompt us to identify the cause of the post-partum contaminations. In the milking room, we could observe deficiencies in the hygiene procedures before milking and the absence of post-dipping. Finally, from the bulk tank milk we can see significant variations in urea and butterfat content, suggesting, at best, less than consistent feeding practices.

5. Conclusions

Mastitis is a polymorphous disease that is difficult to control on a permanent basis, and very costly. Maintaining its prevalence at acceptable levels for a reasonable investment can prove a good on-going cost-benefit strategy. In addition, minor daily actions, such as a change of movements, personnel, equipment, etc. can have a significant effect on mammary health.

Depending on the mode of analysis, it is possible to predict recoveries or, inversely, a worsening of the problems according to the epidemiological orientation with respect to cures and contaminations.
In the light of the development of the typology of European dairy farms, this type of approach enables the examination of a herd to be standardised. For the future, it could also be a good set of indicators for the controlled examination of a herd to be standardised. For the future, European dairy farms, this type of approach enables the monitoring of health performance indicators are quite powerful tools for identifying problems, understanding the exposure pathways and controlling the pathogens involved. But they are not sufficient to guarantee a solution; the farm and its specific constraints must be known.

### References


### Figure 4. Epididymal indicators and instantaneous infection dynamics (taken from LAECEA ULG-AWE Project)

### Figure 5. Time-dependent epidemiology to analyse the variations in the indicators

### Figure 6. Instantaneous mammary health epidemiology (taken from the LAECEA ULG-AWE Project)

### Figure 7. Comparative evolution of tank milk (the black line indicates the moving average of six consecutive results over a continuous period)