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Determinants of antimicrobial treatment for udder health in Danish dairy cattle herds

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ABSTRACT

Societal pressure to limit the use of antibiotics in livestock production systems, including dairy cattle systems, is consistently increasing. To motivate farmers to reduce antibiotic usage, it is important to understand the factors that determine whether a cow will be treated with antibiotics or not. If farmers' usual practices regarding antibiotic treatments are taken into account, they may be motivated to adopt control measures that can facilitate prudent use of antibiotics and are at the same time cost-effective. In this study, we analyzed database recordings of milk yield and somatic cell count from the routine milk recording scheme, clinical registrations of mastitis and PCR results, and cow factors such as days in milk and parity in relation to antibiotic treatments for 518 dairy herds in Denmark. Farm-wise logistic regressions were used to predict antimicrobial treatment based on these factors. The resulting regression coefficients of 422 herds were further analyzed by principal component analysis and clustering to determine the driving predictors for treatment in different groups of farms. The results showed that determinants that were most important for predicting antibiotic treatments vary from one farm to another. Health indicators such as PCR or somatic cell count were most indicative for treatment on some farms, whereas other groups seemed to depend more on production factors (milk yield) or later culling of the cows. This shows that farmers behave differently and differences can be identified in register data. This information can be considered when developing cost-effective herd-specific control measures of mastitis to promote prudent use of antibiotics in Danish dairy cattle farms.

Key words: dairy cattle, antibiotic treatment, mastitis, cluster analysis

INTRODUCTION

Mastitis is one of the most frequent and costly diseases in dairy cattle (e.g., Halasa et al., 2007). Besides impairing animal welfare (Broom, 1991; von Keyserlingk et al., 2009), it is also a major reason for economic losses and prescription of antibiotics in dairy cattle herds (DANMAP, 2014, p. 34; EMA and EFSA, 2017, p. 29). The use of antibiotics in food animals has been a growing concern over the last decades, with increasing consumer awareness regarding this point and its effect on antimicrobial resistance (Ruegg, 2003).

Antimicrobial treatment is an important element in the management of mastitis in dairy herds. It is applied for treatment of clinical mastitis (Steeneveld et al., 2011; Halasa, 2012) and subclinical mastitis (van den Borne et al., 2010), and at dry-off to cure or prevent mastitis cases (Halasa et al., 2009a,b). However, its use must be prudent (i.e., limited to cases in which treatment with antibiotics is necessary while choosing a suitable antibiotic) to reduce the risk of antimicrobial resistance. To optimize antimicrobial usage, it is important to understand antimicrobial treatment patterns for udder health in dairy cattle herds and investigate factors that influence/enhance the treatments. However, it can be challenging to identify what farmers actually do, or why, as such information is not normally registered. Nevertheless, observable factors may give indications and thus may be useful as proxies for behaviors explaining antimicrobial treatment on a farm. Once influential factors are identified for a specific farm, veterinarians and udder health advisors can guide farmers to a prudent and cost-effective selection strategy of cows for treatment, while also taking the farmer's usual selection criteria or management practice into account. This might ease motivating farmers to adopt proposed management programs to improve udder health, thus aiding

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the prudent use of antimicrobials. As blanket dry cow therapy is prohibited in Denmark, an appropriate selection of cows for antibiotic treatment, both during lactation and at dry-off, is expected to have a positive effect on udder health and animal welfare while facilitating prudent use of antibiotics (Scherpenzeel et al., 2016). In Denmark, antimicrobials are prescribed by the herd veterinarian and exclusively distributed through pharmacies. In addition, treatments are normally carried out by veterinarians, but a farmer can have a herd health contract with a consulting veterinarian, allowing him to treat clinical cases of mastitis himself.

The proposed strategies can be developed and examined using, for instance, simulation models adjusted to the herd-specific parameters and with focus on cost effectively optimizing antimicrobial usage. These models can also consider other factors, such as spread of pathogens (e.g., van den Borne et al., 2010; Halasa et al., 2010), and thereby provide a more comprehensive understanding of management and treatment regimens and their expected outcomes, depending on given farm and cow parameters. This knowledge could additionally be used by policy makers when considering new regulations on a national scale.

In Denmark, herd and cow level registrations are collected in the Danish cattle database. They include, in addition to cow ID, for instance, milk yield and SCC from samples obtained through the routine milk recording scheme (6 or 11 times per year), and other recordings as part of a herd health scheme. The data also include recordings about diseases and treatments for individual cows and are being used for, among other purposes, the development of herd health and breeding programs. Its potential for development of herd-specific health management programs can, however, be further exploited.

We investigate if data from the Danish cattle database can be used to predict antimicrobial treatment in relation to udder health management on different farms, and we identify differences between farms regarding treatment and determine which factors are most important for treatment on different farms. This information can be used to develop herd-specific strategies to improve udder health, considering prudent use of antimicrobials and the apparent selection strategy of cows for treatment.

MATERIALS AND METHODS

Data

Anonymized data from 1,500 randomly chosen conventional cattle farms with any milk yield recordings in Denmark, where at least 90% of the animals are Danish Holstein cows, were retrieved from the Danish cattle database between February 27 and March 1, 2016. At this time, the total number of dairy farms in Denmark was 3,232. Data included information on milk yield, SCC, animal movements, reproduction and calving, dry-off dates, PCR results (from cow-milk samples), clinical registrations, and treatments. Clinical registrations are usually carried out by the veterinarian, but some farmers may also add to the registrations. These registrations include mainly the results of the California mastitis test, but also acute mastitis cases. Only data from Danish Holstein cows were considered in the analyses.

As a first step, data irrelevant for udder health management were removed: clinical registrations and treatment recordings in the database are related to various diseases, but only clinical registrations pertaining to the udder or the mammary gland, registered as the Danish equivalents of "udder" or "mammary gland," or results from the California mastitis test were kept. Treatments were considered relevant if they were registered as dry-cow treatment, pertaining to the udder or for diagnosed pathogens causing IMI.

As we were interested in treatment patterns in relation to udder health management, in the second step, we split the data set into 3 parts. The first part included 518 herds with available mastitis PCR results, clinical registrations, and treatment recordings in relation to udder health; the second part included 370 herds without PCR but with available clinical registrations and treatment recordings, and the third part consisted of 424 herds with only treatment recordings available.

From the milk recordings of these farms, average milk yields per parity were calculated for every cow and SCC values were log-transformed. Milk yields recorded as 0 or not available (**NA**), where SCC was also NA, were discarded because they were considered to be automated recordings for cows that were not actually milked (e.g., cows that were just dried off). Log-transformed SCC values that were given as negative infinity were regarded as NA because a SCC of 0 should not be possible. Parity and DIM were calculated according to the given calving dates. Parity was categorized as 1, 2, or $\geq$3, and DIM were categorized as lactation stages in early (0–30 DIM), mid (31–250), late (251–450), and very late (>450 DIM) lactation. Observations in the last lactation of a cow were marked according to animal movements showing death of the cow, with NA signaling that neither death nor a following lactation could be identified. Treatment registrations within 14 d of a previous registration were considered part of the same treatment (Barkema et al., 1998), except if