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The cost of clinical mastitis in the first 30 days of lactation: An economic modeling tool

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ABSTRACT

Clinical mastitis results in considerable economic losses for dairy producers and is most commonly diagnosed in early lactation. The objective of this research was to estimate the economic impact of clinical mastitis occurring during the first 30 days of lactation for a representative US dairy. A deterministic partial budget model was created to estimate direct and indirect costs per case of clinical mastitis occurring during the first 30 days of lactation. Model inputs were selected from the available literature, or when none were available, from herd data. The average case of clinical mastitis resulted in a total economic cost of $444, including $128 in direct costs and $316 in indirect costs. Direct costs included diagnostics ($10), therapeutics ($36), non-saleable milk ($25), veterinary service ($4), labor ($21), and death loss ($32). Indirect costs included future milk production loss ($125), premature culling and replacement loss ($182), and future reproductive loss ($9). Accurate decision making regarding mastitis control relies on understanding the economic impacts of clinical mastitis, especially the longer term indirect costs that represent 71% of the total cost per case of mastitis. Future milk production loss represents 28% of total cost, and future culling and replacement loss represents 41% of the total cost of a case of clinical mastitis. In contrast to older estimates, these values represent the current dairy economic climate, including milk price ($0.461/kg), feed price ($0.279/kg DM (dry matter)), and replacement costs ($2,094/head), along with the latest published estimates on the production and culling effects of clinical mastitis. This economic model is designed to be customized for specific dairy producers and their herd characteristics to better aid them in developing mastitis control strategies.

1. Introduction

Clinical mastitis has been identified as the most common cause of morbidity in adult dairy cows in the United States (NAHMS, 2007). Based on surveys conducted in 1996, 2002, and 2007, the percentages of cows with clinical mastitis increased over time. These surveys also indicated the top reasons cows were permanently removed from a herd were udder or mastitis problems and reproductive problems. Additionally, mastitis and calving problems were the top reasons identified for cow mortality. Clinical mastitis results in many negative outcomes for the cow including pain, decreased production, culling, and death. The dairy producer incurs the cost of these negative outcomes through reduced quality and quantity of milk, as well as increased production costs. Intramammary infections may be subclinical infections in which the mammary secretions are not visually abnormal in color or consistency, or they may result in clinical mastitis (CM) in which there are abnormalities detectable in the milk, udder, or animal (Ruegg, 2011). Although subclinical mastitis is more prevalent than clinical mastitis, the economic impact of subclinical infections is more difficult to quantify and predict across herds due to the variability in herd level screening intensity and case definition. There is significantly more published information regarding the impact of CM on health, productivity and culling risk as compared to subclinical mastitis; thus, this study focuses on CM. Lactational incidence of subclinical and clinical mastitis varies greatly between herds, but the probability of acquiring an infection is consistently higher during the early dry period (Bradley and Green, 2004). The apparent incidence of mastitis that develops during the dry period is very low due to the lack of daily observation of the mammary secretions. However, the highest risk period for the detection of CM is in early lactation (Ruegg, 2011), and includes the detection of infections acquired during the dry period, as well as infections that occurred

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in early lactation. Clinical mastitis in the periparturient period can have a great impact on lactation performance, affecting both the mammary gland and the overall health of the cow. The dry period and the early fresh period represent the greatest opportunity for management interventions to improve, or potentially worsen, the health of the udder and its ability to produce quality milk throughout lactation, as a large proportion of cases are observed or may be attributed to this time period (Natzke, 1981).

Clinical mastitis can result in a wide spectrum of negative consequences, and its severity is commonly scored based on the extent of tissue involvement (Ruegg, 2011; Oliveira and Ruegg, 2014). Mild CM (grade 1) describes an infection limited to clinically abnormal milk; moderate CM (grade 2) also includes an abnormal udder in its clinical presentation; and severe CM (grade 3) corresponds to abnormal milk, an abnormal udder, and systemic signs of disease. Cows affected with different severities of CM are likely to suffer different short and long term health and production consequences, receive different treatments (Oliveira and Ruegg, 2014), and therefore have different economic impacts. Clinical mastitis has direct economic effects including diagnostic costs, treatment costs, the cost of non-saleable milk, labor and veterinary costs, and death, but CM also has long term health effects that influence future milk production (Wilson et al., 2004; Schukken et al., 2009), future culling risk (Miliansuazo et al., 1988; Beaudeau et al., 1995; Grohn et al., 1998), and future reproductive efficiency (Santos et al., 2004).

The economic impact of CM is typically much larger than that of many other clinical diseases of dairy cattle, and much work has been done to estimate losses at the cow level, the herd level, and the industry level. Several methods have been used to estimate the economic effects of mastitis, including partial budgeting (Kossaibati and Esslemont, 1997), dynamic optimization programming (Bar et al., 2008), and decision tree analysis (Pinzon-Sanchez et al., 2011). The differences in these methods, along with different inputs used in the models, result in wide ranges in the published estimates of the economic effects of mastitis (Halasa et al., 2007). Most published work has focused on mastitis that occurs throughout lactation, but little has been done to evaluate the specific impact of mastitis occurring within the first 30 days in milk (DIM). Cows that experience early lactation infections have the potential for greater negative impact due to the preponderance of lactational time remaining. Accurate economic analysis of the disease, and more specifically, a good understanding of the corresponding costs as they relate to early lactation mastitis, is important so the dairy producer can make informed decisions pertaining to the prevention and management of CM on the farm.

The purpose of this study was to create an accurate and customizable tool to be used by dairy veterinary consultants to help their clients assess the economic effects of CM during the first 30 days of lactation in order to better guide decision making and management interventions during the transition period.

2. Materials and methods

2.1. Overview

A deterministic partial budget was created using spreadsheet software (Microsoft Excel, Redmond, WA) to estimate the economic impact of CM that is diagnosed within the first 30 DIM. Model inputs (Table 1 and Table 2) were selected from the available literature based on their scientific merit and applicability, or, when none were available, from clinical experience with actual herd data. In some instances, there was considerable variation in the published impact (most commonly risk ratios or odds ratios) associated with CM. In these cases, a blended mean estimate was used to smooth the impact of a very low or very high estimate. When actual herd data were used, the estimates were derived from a convenience sample of dairy herds assimilated by one of the authors (Overton) from U.S herds that were consistent in size and management approach as described in the model. The cows represented by this compilation include over 30,000 animals from average to above average managed herds that utilized DairyComp305 on-farm management software, were primarily free stall housed, fed total mixed rations balanced by a professional nutritionist, and were located in the upper Northeast, Midwest, Northwest, West or Southwest regions of the U.S.

The economic impact per case of CM was divided into direct and indirect costs. Direct costs include diagnostic testing, therapeutics, non-saleable milk, veterinary service, labor, and death loss. Indirect costs include future milk production loss within the remainder of the current lactation, cost associated with premature culling and replacement, and reproductive loss during the current lactation that is attributable to early lactation mastitis.

Model inputs were based on a typical large Holstein dairy herd using modern production practices in the United States of America with 1000 animals calving per year; 38% of the calvings were assumed to be primiparous animals. The milk price of $0.461 per kilogram of milk was a 3-year average of net pay prices received by dairy farmers for their milk, including all payments received for milk sold and all costs associated with marketing the milk (i.e., mailbox prices) from January 2012 to December 2014 as reported by the USDA Agricultural Marketing Service (USDA, 2014).

Within the model, non-saleable milk could either be discarded or used to feed replacement heifers. This non-saleable milk includes milk from cows with CM, cows being treated with therapies that require milk withdrawal, and milk from cows following therapy but before milk is cleared for human consumption and sale. It was assumed that feeding non-saleable milk to calves would allow producers to displace purchased milk replacer powder. Since historical prices for commercial milk replacer are not typically published by any public information source, the authors obtained the historical monthly price of a commercial 28% protein and 15% fat milk replacer from a U.S. national manufacturer and distributor. The 3-year (January 2012 to December 2014) average price on a fluid basis was $0.426 per kilogram (92.3% of the value of milk). While the cost of milk replacer reflects the value of non-saleable milk that is used to displace purchased milk replacer, this value was discounted to 85% of its cost, since not all non-saleable milk is suitable to be fed to calves, and the supply of non-saleable milk may be greater than the need for calves. Based on this substitution approach, non-saleable milk used to feed calves was assumed to have a value of $0.362 per kg of liquid milk. Thus, the economic loss of a kilogram of non-saleable milk was equal to $0.461 minus $0.362, or $0.099 of lost potential value if the milk had been traditionally marketed.

First lactation fresh animals were valued at $2094 per head, based on a 3-year average of reported prices from January 2012 to December of 2014 (Livestock Marketing Information Center, 2014). The value of older animals was calculated based on a curvilinear depreciation model that accounted for lactation-specific culling risk and expected future salvage value and was equal to $1973 per head. Relative to straight line depreciation, where the market value of a cow depreciates a constant amount per year from the beginning value to the ending value, the model depreciates cows slower in the initial years and then faster in the last years (i.e., market value decreases at an increasing rate from beginning value to ending value). Market price for culled animals was $1.84 per kg live weight, which was a 3-year average of reported prices from January 2012 to December of 2014 (USDA, 2014); the income received for an animal sold was adjusted for the risk of condemnation (White and Moore, 2009). Lactational culling risk, including deaths and animals sold, was 25% for first lactation animals (20.5% sold and 4.5% died), and 46% for mature animals (36% sold and 10% died), as derived