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A stochastic estimate of the economic impact of oral calcium supplementation in postparturient dairy cows

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ABSTRACT

The objective was to develop stochastic models to estimate the economic impact in the first 30 d in milk of oral calcium supplementation to multiparous postparturient dairy cows using 4 different strategies: (1) supplementation of cows with a high previous lactation mature-equivalent milk yield, (2) supplementation of lame cows, (3) supplementation of both cows that have a high previous lactation mature-equivalent milk yield and cows that are lame, and (4) supplementation of all cows. Data from current literature were used to model input variables associated with the costs and risks related to milk production, postparturient disease, and culling. The mean net herd impact per 1,000 calvings for each of the 4 supplementation strategies was $4,425, $5,812, $8,313, and $3,065, respectively. Postpartum supplementation of multiparous lame cows had the highest return on investment at 6.5 to 1, followed by supplementation of multiparous high milk yield and lame cows, multiparous high milk yield cows only, and supplementation of all multiparous postpartum cows with returns of 1.8 to 1, 1.1 to 1, and 0.3 to 1, respectively. A herd's average milk yield at first test had the highest influence on the net impact of oral calcium supplementation to all multiparous cows and accounted for 30% of the variation, followed by the decrease in risk of health events in lame cows given oral calcium at 22%, a herd's prevalence of lameness at calving at 13%, and the price of milk at 10%. Each of the remaining stochastic variables contributed to less than 5% of the variation in net herd financial impact of oral calcium administration. Whereas supplementation of all postpartum multiparous cows returned a positive net herd impact approximately 80% of the time, if a herd was willing to devote time to mature-equivalent milk yield calculations and locomotion scoring, supplementation of this subpopulation of postpartum cows with oral calcium was estimated to have a positive economic impact in all iterations. Depending on the supplementation strategy chosen and baseline milk yield and immediate postpartum lameness prevalence in a herd, a herd with 1,000 calvings per year can expect to see an average net impact ranging from approximately $3,000 to $8,000 after postpartum supplementation of oral calcium in multiparous animals.

Key words: dairy cow, hypocalcemia, oral calcium, economic impact

INTRODUCTION

Hypocalcemia, defined as a low blood calcium concentration around the time of calving with or without clinical signs, is a costly problem for dairy producers. Compromises associated with hypocalcemia include reduced DMI at the start of lactation, decreased milk yield, increased risk for parturient diseases such as retained placenta, metritis, displaced abomasum (**DA**), and mastitis, increased risk for premature removal from the herd, and decreased reproductive performance (Chapinal et al., 2011, 2012; Martinez et al., 2012).

Prevention of hypocalcemia in postparturient dairy cows includes prepartum management to reduce DCAD, provision of a calcium-deficient diet, or vitamin D supplementation (Goff and Horst, 1997; Goff, 2004; Lean et al., 2006). Unfortunately, no on-farm, cost-effective diagnostic methods are available for individual animal blood calcium concentration measurement. Thus, it is often unknown if intervention in the immediate postpartum period is actually prevention or treatment of hypocalcemia. Common postpartum interventions include subcutaneous or intravenous administration of calcium salts, oral drenching with calcium propionate, or oral administration of calcium pastes or boluses (Pehrson et al., 1998; Goff, 2008; Oetzel and Miller, 2012). Because the postparturient calcium concentration of many animals receiving treatment is not known, benefits from these treatments are often measured by a lack of progression to a more severe hypocalcemia and

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subsequent development of clinical symptoms of milk fever or improvement in cows already diagnosed with milk fever.

Recent research by Oetzel and Miller (2012) showed the effectiveness of an oral calcium bolus (Bovikalc, Boehringer Ingelheim Vetmedica Inc., St. Joseph, MO) in improving early lactation milk yield and decreasing the number of postcalving health events in targeted subpopulations of multiparous cows, specifically cows with a high previous lactation mature-equivalent milk yield or that were lame at calving. However, the economic impact of treatment using oral calcium supplementation or other methods of calcium administration has not been explored.

Many economic analyses use deterministic modeling, which involves the use of fixed costs to estimate an outcome. Stochastic Monte Carlo modeling approaches are able to account not only for inputs normally used as fixed costs, such a disease risks and production costs, but also their variability (for example, fluctuations in the price of milk, cost of a replacement cow, and feed prices). This approach allows an estimation of the mean return on investment as well as a range around the estimate, providing a worst-case and best-case scenario and predictions of how likely each of these returns will occur.

The objective of this study was to develop stochastic Monte Carlo models to estimate the economic impact in the first 30 DIM of oral calcium supplementation to multiparous postparturient dairy cows using 4 different strategies: (1) supplementation of cows with a high previous lactation mature-equivalent milk yield, (2) supplementation of lame cows, (3) supplementation of both cows that have a high previous lactation mature-equivalent milk yield and cows that are lame, and (4) supplementation of all cows.

MATERIALS AND METHODS

Model Inputs

Model input variables used to estimate the economic impact of oral calcium supplementation to multiparous postparturient dairy cows are in Table 1. Data used to create input variables are based on the following information.

Herd, Milk, Labor, and Feeding Inputs. Average milk yield at first test was based on data from approximately 1.3 million cows in 20,897 herds that send Dairy Herd Information Association (2014) data to Dairy Records Management Systems (Raleigh, NC). Mailbox milk prices were collected for 3 yr from 2011 to 2014 from the USDA Agricultural Marketing Service (2014b) and ranged from $0.38 to $0.57 per kg of milk. National average dairy feed cost data were collected for the same period from the University of Wisconsin (Gould, 2014) and ranged from $0.27 to $0.38 per kg of DM feed. Farm labor cost was based on information from the USDA Agricultural Marketing Service (2014b) after incorporating a 30% increase to account for employee benefits. The times to conduct prefresh locomotion scoring, manage milk production and lameness data, identify a high mature-equivalent milk yield cow or lame cow and administer a calcium bolus, and manage a health event were based on field trials previously conducted by the research group. The costs of a calcium bolus and calcium administration gun were based on cost through a veterinary distributor (MWI Veterinary Supply, Boise, ID) with an additional 15% markup.

Herd Removal Inputs. The risk of herd removal was based on data from McArt et al. (2015). The cost of a replacement cow was based on data collected during a 1-yr period from 2013 to 2014 through the USDA Agricultural Statistics Service (2014a) using a minimum and maximum value of $1,200 and $1,650, respectively. The value of a cow sent to slaughter (545 kg cow) was based on data collected during a 3-yr period from 2011 to 2014 through the USDA Agricultural Statistics Service (2014a) and ranged from $780 to $1,452. The disposal cost for a dead cow varied between on-farm composting and removal by a renderer and ranged from $0 to $100. The ratio of sold to dead cows in the first 30 DIM was based on unpublished data from McArt et al. (2012) and McConnel et al. (2008) and estimated at 60% sold and 40% death.

Disease Event Inputs. The risk of metritis, hyperketonemia, DA, mastitis, and pneumonia was based on unpublished data from Chapinal et al. (2011), McArt et al. (2013), Shaver (1997), Wilson et al. (2004) and Olde Riekerink et al. (2008), and the National Animal Health and Monitoring System (2007), respectively. The cost per case of metritis, hyperketonemia, and DA was based on McArt et al. (2015). The cost per case of mastitis was based on Rollin and Overton (2014). The cost per case of pneumonia was based on estimated discarded milk and treatment costs only because, to the authors' knowledge, no published estimates are available of a cost per case of pneumonia in adult animals. The increased risk of health events given lameness were based on Oetzel and Miller (2012), with a minimum increased risk of a health event for a lame cow of 1.31 and a maximum risk of 2.19.

Health and Production Response Inputs. Variables associated with oral calcium supplementation health and production responses were based on data from Oetzel and Miller (2012). The mean effects were increased and decreased by 25% to obtain the minimum

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