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An observational cohort study on persistency of internal teat sealant residues in milk after calving in dairy cows

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ABSTRACT

Our objectives were to evaluate the prevalence of quarters with an observable internal teat sealant (ITS) plug at first milking following calving and investigate persistency of ITS residues in milk after calving. An observational cohort study was carried out on 557 quarters of 156 cows treated with ITS in 6 farms in Quebec, Canada. The presence of an ITS plug at first milking and ITS residues in milk at each milking were observed by producers. The effects of various factors on the odds of observing an ITS plug and persistency of ITS residues in milk were studied using generalized logistic mixed and generalized negative binomial mixed models, respectively. Milk samples were taken on the day before dry-off and on 2 occasions after calving for bacterial identification to detect intramammary infection (IMI) using bacteriological culture followed by MALDI-TOF identification. The association between the absence of an ITS plug and the presence of new IMI was assessed using a mixed logistic regression model. Internal teat sealant plugs after calving were more often observed in rear quarters and in quarters receiving ITS alone at drying-off versus antimicrobial and ITS. We observed an average (standard deviation) persistency of 4.0 d (2.3 d). When an ITS plug was still present at first milking (83% of quarters), the elimination of ITS residues in milk after calving was significantly longer (4.5 d, on average) compared with 1.2 d when an ITS plug was absent. In cows with an ITS plug at calving, we observed a higher number of days of excretion in older cows. When a plug could not be observed, rear quarters, older cows, and cows with a long dry period duration excreted ITS residues for a significantly longer

period. The lack of a significant association between the absence of a plug and the odds of new IMI at calving suggests that despite the loss of the plug, cows were still protected against new IMI. Although we were able to highlight some statistically significant risk factors explaining persistency of ITS residues following calving, observed differences were often relatively small and, perhaps, not clinically relevant. In conclusion, an ITS plug was present until first milking after calving for 83% quarters, quarters without an ITS plug at first milking appeared to have been protected from new IMI, and ITS residues could be observed in milk up to 12 d in milk.

Key words: internal teat sealant, residue, intramammary infection, calving, dry period

INTRODUCTION

Dairy cows are at high risk of developing new IMI (NIMI) during the dry period, which often remain undetected until calving or even a long time after calving in some cases (Smith et al., 1985; Bradley, 2002). These dry-period-acquired NIMI combined with IMI that persist from the previous lactation are important determinants of the IMI prevalence in the subsequent lactation (Green et al., 2002). Factors that influence the susceptibility to NIMI at the beginning of the dry period include the functional transition associated with mammary involution, the delay in the complete formation of keratin plug in the teat canal, and the cessation of teat sanitization (Smith et al., 1985; Dingwell et al., 2003; Halasa et al., 2009). In fact, a previous study in New Zealand observed that 50% of teats did not develop a keratin plug during the first 10 d of the dry period (Williamson et al., 1995). Furthermore, other studies reported that 23% of teats were still open up to 6 wk after drying off and, for 3 to 5% of teats, a keratin plug was never observed (Williamson et al., 1995; Dingwell et al., 2004).

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To prevent NIMI during the dry period, the application of an internal teat sealant (ITS) alone or combined with the administration of antimicrobial is now widely used. An ITS forms a physical barrier to the entry of bacteria responsible for mastitis and thus reduces the risk of NIMI occurring during the dry period (Berry and Hillerton, 2002a; Godden et al., 2003; Sanford et al., 2006). For example, Orbeseal (Zoetis Canada, Kirkland, Quebec, Canada) is an ITS consisting of bismuth subnitrate formulated into an inert viscous malleable paste. It is a sterile and non-antimicrobial intramammary infusion. Use of ITS can complement or provide an alternative to antimicrobial dry cow therapy to protect quarters during the dry period (Woolford et al., 1998; Berry and Hillerton, 2002b; Huxley et al., 2002). Such strategy, which does not involve antimicrobials, is of considerable importance because of public health concerns on antimicrobial resistance and antimicrobial residues in milk. The ITS is not absorbed systemically from the mammary gland and can persist in the teat for at least 100 d during the dry period (Woolford et al., 1998). It remains in the teat cistern over the dry period until it is physically removed manually at first milking, or by suckling by the calf.

Currently, few studies have evaluated the proportion of quarters at first milking after calving that still have an ITS plug. The proportion of quarters truly protected through the entire dry-off period is, therefore, not well described. Furthermore, it is not clear whether quarters, having lost the sealant plug before first milking, were still substantially protected from NIMI during the dry period. Finally, the risk factors that may influence the persistence of sealant plug until the first milking are not well described.

Moreover, few data are currently available on the persistency of ITS residues in milk after calving and on factors affecting ITS excretion following calving have not been reported. Some authors reported presence of sealant residues in milk up to 3 wk after calving (Berry and Hillerton (2002a). Bhutto et al. (2011) reported that most of the product was eliminated at the first milking, but that some residues may be observed over the subsequent milkings. However, these authors did not investigate the average duration of residue excretion.

Consequently, the primary objectives of the current study were to (1) quantify prevalence of quarters with an observable sealant plug at first milking following calving, (2) investigate persistency of ITS residues in milk after calving, and (3) identify risk factors that could affect presence of an ITS plug at calving and number of days of ITS excretion after calving. A secondary objective of the study was to investigate whether

quarters without an observable sealant plug at the first milking after calving were equally protected from NIMI acquisition during the dry period compared with those with an observable sealant plug.

MATERIALS AND METHODS

Participants

The current study was an observational cohort study performed on 557 quarters from 156 cows treated with ITS in 6 dairy farms in Quebec (Canada) between October 2015 and July 2016. This cohort of 6 farms was a convenience sample from a larger randomized controlled trial (RCT) on quarter-based selective dry cow therapy conducted on 9 farms. From that larger sample, only farms where the milking staff agreed to record the presence of residues in milk following calving were selected. For the RCT, herd inclusion criteria were (1) a bulk tank SCC mean <250,000 cells/mL over the last year, (2) a targeted dry period of 35 to 75 d, (3) participation in a DHI program, and (4) willingness to commit to the project protocol. In these herds, all pregnant dairy cows ready for drying-off, having at least 3 functional quarters, and not treated with antimicrobials during the 14 d before dry-off were enrolled. Cows that failed to meet the inclusion criteria were treated as per routine farm procedures for dry-off.

In the RCT, a total of 574 cows were recruited and allocated, using a random number generator, to 4 groups: (1) intramammary (IMM) infusion of dry cow antimicrobial therapy alone; (2) IMM infusion of dry cow antimicrobial therapy and ITS; (3) on-farm culture using a Petrifilm Aerobic Count Plate (3M, London, Ontario, Canada) with positive quarters (defined as ≥ 5 cfu/mL on the Petrifilm Aerobic Count Plate) treated with IMM infusion of dry cow antimicrobial therapy alone and negative quarters treated with ITS alone; and (4) on-farm culture using Petrifilm with positive quarters treated with IMM infusion of dry cow antimicrobial therapy and ITS and negative quarters treated with ITS alone. Farm staff were blinded to treatment allocation, and therefore, they could not choose a group for a cow or keep her out of the study.

For the current cohort study, conducted on 6 of these farms, only quarters dry treated with ITS alone, or with an antimicrobial and ITS were selected. These quarters received, based on group allocation and dry-off IMI status, 4 g of an ITS containing 65% wt/wt of bismuth subnitrate (Orbeseal) with or without an IMM infusion of dry cow antimicrobial (200,000 IU of Penicillin G Procaine and 400 mg of Novobiocin; Novodoxy Plus, Zoetis Canada, Kirkland, Quebec, Canada). All

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