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Use of a culture-independent on-farm algorithm to guide the use of selective dry-cow antibiotic therapy

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ABSTRACT

An algorithm using only computer-based records to guide selective dry-cow therapy was evaluated at a New York State dairy farm via a randomized field trial. DairyComp 305 (Valley Ag Software, Tulare, CA) and Dairy Herd Improvement Association test-day data were used to identify cows as low risk (cows that might not benefit from dry-cow antibiotics) or high risk (cows that will likely benefit). Low-risk cows were those that had all of the following: somatic cell count (SCC) ≤200,000 cells/mL at last test, an average SCC ≤200,000 cells/mL over the last 3 tests, no signs of clinical mastitis at dry-off, and no more than 1 clinical mastitis event in the current lactation. Low-risk cows were randomly assigned to receive intramammary antibiotics and external teat sealant (ABXTS) or external teat sealant only (TS) at dry-off. Using pre-dry-off and postcalving quarter-level culture results, low-risk quarters were assessed for microbiological cure risk and new infection risk. Groups were also assessed for differences in first-test milk yield and linear scores, individual milk weights for the first 30 d, and culling and mastitis events before 30 d in milk. A total of 304 cows and 1,040 quarters in the ABXTS group and 307 cows and 1,058 quarters in the TS group were enrolled. Among cows to be dried, the proportion of cows that met low-risk criteria was 64% (n = 611/953). Of cultures eligible for bacteriological cure analysis (n = 171), 93% of ABXTS cured, whereas 88% of TS cured. Of the noncures, 95% were contributed by the minor pathogens coagulase-negative staphylococci (n = 19/20). These organisms also accounted for 57.5% of new infections (n = 77/134). We found no statistical differences between treatment groups for new infection risk (TS = 7.3% quarters experiencing new infections; ABXTS = 5.5%), milk production (ABXTS = 40.5 kg; TS = 41.2 kg), linear scores (ABXTS = 2.5; TS = 2.7), culling events (ABXTS, n = 18; TS, n = 15), or clinical mastitis events (ABXTS, n = 9; TS, n = 5). Results suggest that the algorithm used decreased dry-cow antibiotic use by approximately 60% without adversely affecting production or health outcomes.
Key words: selective dry-cow therapy, mastitis

INTRODUCTION

The rate of clinical mastitis for cows is highest within the 2 wk postcalving compared with any other time during lactation and is associated with IMI with major pathogens during the dry period (Green et al., 2002). By using serial culture throughout this period, groups have confirmed that most clinical mastitis cases are contributed by chronic subclinical or newly acquired cases from dry-off to calving (Todhunter et al., 1991; Bradley and Green, 2000; Green et al., 2002).

Dry-cow antimicrobial administration was developed and implemented in the 1960s as part of a series of management strategies to mitigate the high incidence of IMI in early lactation (Neave et al., 1966; Smith et al., 1966). A survey by the National Animal Health Monitoring System in 2014 indicated that over 90% of cows are treated and 90% of operations use antimicrobial products at dry-off (USDA-APHIS, 2016a). This suggests that blanket dry-cow therapy (**BDCT**) is widely used; all quarters are treated with a long-acting antimicrobial immediately after the last milking. Success of mastitis control programs is indicated by the increase in negative quarter-level culture results at dry-off from 44% in 1985 to between 73 and 95% of quarters within the last decade (du Preez and Greeff, 1985; Pantoja et al., 2009; Rajala-Schultz et al., 2011). The decreased prevalence of contagious mastitis pathogens and reduction of bulk tank somatic cell counts (**BTSCC**) also suggests that BDCT is not currently a necessity in all herds (Ekman and Østerås, 2003; Robert et al., 2006b). Finally, concerns exist for nonprudent use of antimicrobials in regards to public health

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consequences. For these reasons, Nordic countries have adopted restrictions that permit only selective use of antimicrobials, leading to reductions of approximately 80 and 40% for dry-cow and clinical mastitis treatments, respectively (Ekman and Østerås, 2003). External or internal teat sealants are additional technologies that can offer further protection against new IMI and are readily available in the United States (Crispie et al., 2004; Timms, 2004; Krömker et al., 2014). Selective treatment of cows at dry-off might produce economic returns via decreased labor and dry-tube costs, even when increases in incidence of mastitis are accounted for (Huijps and Hogeveen, 2007; Scherpenzeel et al., 2016).

Selective dry-cow therapy (**SDCT**) identifies and treats cows currently infected or at higher risk for infection during the dry period and is an alternative to BDCT. Several approaches to SDCT have been investigated, including culture-based diagnostics (Cameron et al., 2014; Patel et al., 2017). Although culture remains the gold standard for diagnosing an IMI, there are disadvantages to its use, including costs and time associated with materials, sampling, and labor. Culture-independent cow-side tools such as the California Mastitis Test and milk leukocyte differential tests are available and have been used in SDCT protocols (Poutrel and Rainard, 1981; Hockett et al., 2014). Fair to good sensitivities and specificities have been reported for diagnosing IMI from late-lactation milk samples using these tests, depending upon cut-point and interpretation (Godden et al., 2017). Use of a single composite SCC before dry-off to serve as a proxy for inflammation and infection has also been used to identify cows to be treated (Schukken et al., 1993; Scherpenzeel et al., 2014). However, identification and treatment of high-SCC cows or quarters at dry-off based upon 1 time point was shown to have negative consequences on udder health in several studies (Schukken et al., 1993; Scherpenzeel et al., 2014). Last, combination screening using SCC, mastitis history, with or without bacteriologic culture has produced beneficial effects for several outcomes, but successful implementation can be farm-dependent (Rajala-Schultz et al., 2011; Cameron et al., 2014, 2015).

Our group tested a culture-independent method using only on-farm data in the form of a computer-driven algorithm to guide SDCT. Ninety-eight percent of large dairies (>500 cows) use an on-farm computer record-keeping system, and 82.7% of cows in the United States are housed on operations that use these systems (USDA-APHIS, 2016b). Our approach was to use DHIA and DairyComp 305 (Valley Ag Software, Tulare, CA) records employed by 72.4 and 68% of large US dairies, respectively (USDA-APHIS, 2016b), to determine whether a cow was at low or high risk for having or acquiring an infection during the dry period. Our objective was to use an algorithm to identify low-risk cows and then compare outcomes (bacteriological cure, new infection risk, milk production, linear scores, mastitis cases, and culling) between those receiving IMM antibiotics and external teat sealant at dry-off and those receiving external teat sealant only.

MATERIALS AND METHODS

This randomized field trial was performed at a New York State commercial dairy milking 1,800 cows between June 2016 and March 2017. The rolling herd average milk production, BTSCC, culling rate, monthly clinical mastitis incidence, and 21-d pregnancy rate were 13,388 kg, 201,000 cells/mL, 36.2%, 2%, and 20%, respectively. Cows were housed in freestalls with reclaimed sand and calved in a pen bedded with straw. The trial herd milked most cows 3 times per day while late-lactation animals were milked twice per day. All cows eligible for dry-off according to guidelines defined by the dairy (pregnant >220 d or pregnant >180 d and producing <11.4 kg of milk) were considered for inclusion. This farm used DHIA services, which included monthly SCC and milk weights, and DairyComp 305 (**DC305**; Valley Ag Software) for recording mastitis and culling events.

Sample Size Calculation

The primary outcome was new IMI at freshening, which has a documented prevalence of 6.4 to 25% at the quarter level (Godden et al., 2003; Pantoja et al., 2009; Arruda et al., 2013). Using a prevalence of 15%, an α level of 0.05, a power of 80%, and the ability to detect a change in risk of 5%, a sample size of 1,884 (942 quarters per group; 236 cows) would be required. After accounting for a 20% loss to follow-up, the sample size amounts to 2,261 quarters, or a total of 565 cows (approximately 300 cows per group).

Algorithm Details, Treatment Allocation, and Sampling Procedures

This study was approved by Cornell University Institutional Animal Care and Use Committee (approval #2013-064). Each cow eligible for dry-off was classified into low- or high-risk groups based on the following algorithm: a low-risk cow was defined as having an average SCC over the last 3 tests before dry-off of ≤200,000 cells/mL, an SCC ≤200,000 cells/mL on the last test, and no more than 1 case of clinical mastitis in the current lactation. The expected dry period had