J. Dairy Sci. 100:1–9
https://doi.org/10.3168/jds.2016-11514

Anatomical characteristics of teats and premilking bacterial counts of teat skin swabs of primiparous cows exposed to different types of bedding

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ABSTRACT

Bacterial populations of teat skin are associated with risk of intramammary infection and may be influenced by anatomical characteristics of teats. The objective of this study was to evaluate associations of selected anatomical characteristics of teats with bacterial counts of teat skin of cows exposed to different types of bedding. Primarily primiparous Holstein cows (n = 128) were randomly allocated to 4 pens within a single barn. Each pen contained 1 type of bedding [new sand (NES), recycled sand (RS), deep-bedded manure solids (DBMS), and shallow-bedded manure solids over foam core mattresses (SBMS)]. During a single farm visit udders (n = 112) were scored for hygiene and 1 front (n = 112) and 1 rear teat (n = 111) of each enrolled cow were scored for hyperkeratosis (HK). Teat length, teat barrel diameter, and teat apex diameter were measured and teat skin swabs were systematically collected for microbiological analysis. Linear type evaluation data for udders of each cow were retrieved for each cow. Teat position (front or rear) was associated with occurrence of clinical mastitis during the 12 mo before the farm visit and more cases occurred in front quarters. The proportion of udders that were classified as clean (score 1 or 2) was 68, 82, 54, and 95% for cows housed in pens containing NES, RS, SBMS, and DBMS, respectively. No association was found between HK score and teat position and no association was found between HK score and teat skin bacterial count. Bacterial counts of teat skin swabs from front teats of cows in pens containing RS and SBMS were significantly less than those of rear teats of cows in pens containing DBMS or NES. Teat skin bacterial counts were significantly greater for swabs obtained from teats of cows with udder hygiene scores of 3 and 4 as compared with swabs obtained from cows with cleaner udders. Of all udder conformation traits evaluated, only narrower rear teat placement was positively associated with bacterial counts on teat skin.

Key words: dairy, hygiene, hyperkeratosis, teat

INTRODUCTION

Mastitis continues to be the most common and economically important disease of dairy cows located in developed dairy regions (Seegers et al., 2003; Ruegg and Erskine, 2014). Mastitis is an inflammation of the udder that usually occurs in response to IMI after pathogenic microorganisms enter through the teat canal (Hogan et al., 1999). According to Vanderhaeghen et al. (2015) bacteria can be classified as host-adapted versus environmental and as contagious versus opportunistic. Contagious bacteria originate from infected quarter(s) and spread among cows (usually via a fomite) whereas opportunistic bacteria have multiple sources (usually in the environment). In North America, the widespread adoption of modern management practices has resulted in an overall decrease in prevalence of IMI and a greater proportion that are caused by opportunistic (rather than contagious) pathogens (Makovec and Ruegg, 2003; Pinzón-Sánchez and Ruegg, 2011; Schukken et al., 2011). Prevention of environmental mastitis is based on reduction of exposure of teats and ensuring excellent udder hygiene. Dairy cattle spend 12 to 14 h per day lying down (Tucker and Weary, 2004), and during this time their teats are intimately exposed to potential pathogens in their environment (Hogan et al., 1989). The risk of IMI has been previously associated with teat dimensions (Slettbakk et al., 1995; Zwertvaegher et al., 2013). In a recent case-control study, we demonstrated that increased diameter of the teat apexes of front teats was associated with increased risk of clinical mastitis (Guarín and Ruegg, 2016). Likewise, for front (but not rear) teats, we recently observed that greater diameter of the teat apexes was associated with increased SCC (Guarin et al., 2017). These associations may indicate that front teats with wider apexes have reduced ability to resist IMI caused by opportunistic bacteria and emphasize the importance of understanding

Received May 26, 2016.
Accepted October 14, 2016.
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the magnitude of bacterial exposure based on bedding type. The relationship of teat dimensions with bacterial counts of teat skin and possible relationship with IMI is not well defined. The objective of the current study was to evaluate potential associations of selected teat anatomical characteristics with bacterial counts of teat skin swabs obtained from primiparous cows exposed to different types of bedding.

MATERIALS AND METHODS

Herd Selection

This study was conducted at the University of Wisconsin–Madison, Marshfield Research Station and was approved by the Animal Care and Use Committee at the University of Wisconsin-Madison (Protocol # A-01–488). Details of the freestall barn, bedding, and the cows' diet have been previously described (Rowbotham and Ruegg, 2016). In brief, the freestall barn contains 4 equally sized pens each containing 32 head-to-head stalls. Each of the 4 pens contained a single type of bedding material: deep-bedded new sand (**NES**), deep-bedded recycled sand (**RS**), deep-bedded manure solids (**DBMS**), or shallow-bedded manure solids over foam core mattresses (**SBMS**). Manure was removed from stalls twice daily and bedding was added to the back of the stalls twice weekly. This facility is part of other ongoing environmental studies and contains primarily primiparous Holstein cows. The pens accommodate up to 32 cows each (maximum of 128 cows) and occasionally if the pens are not full, a few multiparous cows are moved to that facility to maintain cow numbers for the other studies.

Sample Collection and Randomization

Except for the linear type data that were based on evaluations performed by classifiers of the Holstein Association, 2 researchers (J. F. Guarín and C. Baumberger) collected all data and performed all measurements during a single farm visit. Before premilking teat preparation, data were collected by (1) assigning an udder hygiene score (**UHS**), (2) swabbing teats, and (3) measuring teat dimensions (from the same teats that were swabbed). The milking technician then completed premilking preparation and attached the milking unit. After the milking units were automatically detached (4) hyperkeratosis scores were assigned (from the same teats that were swabbed and measured). After all animal observations were collected, (5) cow data were extracted from herd management software (DairyComp 305, Valley Agricultural Software, Tulare, CA) and (6) a representative bedding sample was collected from each of the 4 evaluated pens.

Udder hygiene scoring was performed as described by Schreiner and Ruegg (2003) on 111 primiparous cows and 1 second-lactation cow, which were evenly distributed in the 4 pens. Teat skin swabs were collected from all enrolled teats (n = 224) of 28 cows per pen by the same experienced researcher (C. Baumberger) after cows entered the parlor but before premilking teat sanitation. Teats were sequentially enrolled using the sequence: left front and right rear, or right front and left rear. Skin of 1 front and 1 rear teat of 28 cows in each of the 4 pens was systematically swabbed using a single sterile rolled-gauze swab (10.2 × 10.2 cm) moistened in buffered peptone water (Becton, Dickinson and Company, Sparks, MD) for each teat, as previously described by Baumberger et al. (2016). In brief, the bottom 2 cm of one side of the teat was wiped, followed by rotating the swab around the teat apex and swabbing the bottom 2 cm of the other side of the teat. The swab was immediately immersed in 4 mL of buffered peptone water and maintained on ice until it arrived at the University of Wisconsin Milk Quality laboratory for microbiological analysis.

Teat dimensions of all enrolled cows (n = 112) were measured by a single researcher (J. F. Guarín) before unit attachment, as previously described (Guarín and Ruegg, 2016). Briefly, the length, barrel diameter, and teat apex diameter were measured using a translucent measuring ruler with a scale unit of 2 mm, which illuminated the teats with a white lamp (WestfaliaSurge, Inc., Naperville, IL). All measurements were video recorded using a GoPro HERO3 camera (GoPro Inc., San Mateo, CA).

Hyperkeratosis scores were determined using a 4-point scale as no ring (**N**), smooth or slight ring (**S**), rough ring (**R**), very rough ring (**VR**; Mein et al., 2001). Parity, DIM, DHIA SCS, 305-d milk production, and health events of each cow (n = 112) were collected from herd management software (Dairy Comp 305; Valley Agricultural Software). Clinical mastitis cases were defined as the production of abnormal milk with or without secondary symptoms. This definition was used by the trained milking technicians at the Marshfield Research Station of the University of Wisconsin who detected mastitis during premilking preparations and recorded all the information and outcomes of the disease at the quarter level.

Linear type data based on evaluations performed by classifiers of the Holstein Association (http://holsteinusa.com) were available for 103 animals and used to assess potential associations of several udder conformation traits with teat skin bacterial count. The linear