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Short communication: The effect of novel antiseptic compounds on umbilical cord healing and incidence of infection in dairy calves

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ABSTRACT

The goal of dipping the umbilical cord after birth in calves is to promote healing of the umbilical stump, prevent infection, and encourage the umbilical tissue to detach from the body. Treatment applied to the umbilical area is an important management step for preventing morbidity and mortality in calves. The objective of this study was to compare the effect of 4 umbilical dips on the healing rate, incidence of infection, and age at umbilical cord detachment using newborn Holstein heifer calves (n = 73). Calves were alternately assigned by birth order to 4 treatment groups: 7% iodine, a dry dip formulated using an antibacterial peptide (nisin) mixed with talc (3.105 g of nisin per 100 g of talcum powder on a weight per weight basis), liquid nisin (64 μg/mL), and 4% chlorhexidine mixed with alcohol in a 50:50 solution. Umbilical cords were dipped 30 min after birth. Before initial dipping, umbilical cord diameter (as an indicator of the rate of cord drying and healing rate) was determined using a digital caliper. The caliper measurements were repeated at 24 ± 1, 48 ± 1, and 72 ± 1 h (±standard deviation) of age and were continued daily until the umbilical cord healed and detached from the animal's body. Diagnosed umbilical infections were documented by veterinary staff based on a combination of clinical symptoms (redness, swelling, purulent discharge, painful response (flinch or kicking) to palpation of the umbilical stump) in addition to a lack of appetite and fever. Data were analyzed using MIXED model procedures with fixed effect of umbilical treatment. No treatment differences were noted between dips on the umbilical cord drying rate or days for umbilical cord to detach. Treatment effects were observed on incidence of umbilical infection (incidence of infection for calves across all treatments was 9.0%).

Key words: antiseptic compound, calf, umbilical cord, umbilical infection

Short Communication

The umbilical cord is an important placentally derived structure that maintains the blood supply between the fetus and the placenta throughout pregnancy. The umbilical cord ruptures by way of a tearing process, severing the umbilical artery and vein during the last stage of the birth process, leaving an umbilical stump and umbilical cord remnant on the calf's abdomen. This cord remnant and umbilicus stump, if not disinfected, may become a site for pathogen entry that increases the calf's risk of septicemia. Umbilical infections are not only a health risk for the animal, but also reduce total BW gain during the first 3 mo of the calf's life (Virtala et al., 1996a). Studies indicate that between 5 and 20% of dairy calves in the United States develop umbilical infections (Virtala et al., 1996b; Mee, 2008) and 1.6% of reported calf deaths are related to umbilical infections (USDA, 2010).

Typically, antiseptic compounds are used to help clean, sanitize, and improve the rate of umbilical stump healing while reducing the risk of infection for the animal. The 2 most common antiseptic compounds used in the dairy industry are 7% iodine or 4% chlorhexidine (Mee, 2008). Careful and routine umbilical cord care with an antiseptic and keeping the calf in a clean, dry, well-ventilated area can substantially decrease calf mortality and morbidity (Mee, 2008).

Iodine is produced and commercially available in many concentrations. Seven percent iodine concentration is strong enough to kill most pathogens with a short contact time, and alcohol has been reported to assist in an increased umbilical stump desiccation rate (Imdad et al., 2013). Iodine is bactericidal, sporicidal, cysticidal, and virucidal (WHO, 1999). However, the sale, shipping, and storage of 7% iodine solutions has become more challenging in recent years due to increased federal regulations (US Department of Justice, 2007), which has created the need to explore antiseptic alternatives.

Chlorhexidine is a good alternative antiseptic for producers due to the broad spectrum of activity against both gram-positive and gram-negative bacteria; in ad-

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dition, it has a relatively long duration of activity, low toxicity, and typically does not irritate skin to the same extent as iodine (Imdad et al., 2013; Sinha et al., 2015). Previous literature in human infants provides consistent evidence that 4% chlorhexidine can reduce both umbilical cord and periumbilical infection risk (Mullany et al., 2003). To decrease costs, some producers will mix alcohol with chlorhexidine. However, alcohol does not promote drying, is less effective against bacteria than other antimicrobials, and delays cord separation due to tissue damage (WHO, 1999).

Nisin is a natural antimicrobial peptide that was isolated from *Lactococcus lactis* in 1947 and is the oldest known lantibiotic (Mattick and Hirsch, 1947). It is a nontoxic polypeptide with antimicrobial properties (Tong et al., 2014). Potentially, nisin is a safe alternative to more traditional chemical germicides, such as iodines and chlorhexidines, and is now being explored for other medical usages. Nisin possesses antibacterial activity against a broad range of gram-positive bacteria and a small number of gram-negative bacteria (Tong et al., 2014). Sears et al. (1992) showed a nisin-based formulation used as a postmilking teat dip decreased mastitis and showed a mean log reduction of 3.90 against *S. aureus* and 4.22 log reduction against *E. coli* after a 1 min exposure to the germicide. Currently, nisin is widely used as an antimicrobial peptide in food preservation (Tong et al., 2014), as well as the primary ingredient in a cow teat wipe used to clean and sanitize the teat area before and after milking (Immucell Corp., Portland, ME). This commercial teat wipe product uses nisin to dramatically reduce levels of common mastitis pathogens, including *Staphylococcus aureus*, *Streptococcus agalactiae*, *Escherichia coli*, *Streptococcus uberis*, and *Klebsiella pneumoniae* (Broadbent et al., 1989). The scientific literature on the most common bacteria causing umbilical infections in animals is very limited; however, group B *Streptococcus* organisms, *S. aureus*, and *E. coli* are the primary pathogens that cause umbilical infections in infants (Mullany et al., 2003). These data suggest that gram-positive bacteria normally present in feces can significantly contribute to the risk of umbilical infections. Nisin can be incorporated in both dry umbilical antiseptic formulations (created by mixing the compound with talcum powder to potentially increase the umbilical tissue drying and healing rate) as well as in a liquid form, similar to other traditional antiseptics.

The purpose of this study was to address the need in the industry to provide producers with an alternative to iodine and chlorhexidine. To accomplish this objective, the effect of 4 umbilical dips on the healing rate, incidence of infection, and age at umbilical cord detachment using newborn Holstein heifer calves (n = 73) was compared. The number of calves enrolled in this study was limited to the number of heifer calves born within the defined study time frame (6 mo).

The Iowa State University Animal Care and Use Committee approved this project (log #10–14–7881-B). Holstein heifer calves (n = 73) were enrolled in this trial and monitored at the Iowa State University Dairy Teaching and Research Facility (Iowa State University, Ames) during June through November 2015. All heifer calves were moved within the first hour after birth from the maternity pen to an individual 1.2 m × 1.8 m calf pen that was bedded with straw within a 96-stall, 4-row indoor calf facility. Calves were alternately assigned by birth order to 4 treatment groups: 7% iodine (**I**), a dry dip formulated using an antibacterial peptide (nisin) mixed with talc (3.105 g of nisin per 100 g of talcum powder on a weight per weight basis; **DN**), liquid nisin (64 μg/mL; **LN**), and 4% chlorhexidine mixed with alcohol in a 50:50 solution (**CH**). Due to the farm's accepted standards for minimum care, no negative control was used in this trial. Before initial umbilical cord dipping, umbilical cord diameter (an indicator of cord desiccation rate and healing) was measured by trained research personnel using a digital caliper (Mitutoyo 500–197–30 Absolute Digital Caliper, Aurora, IL). This measurement was taken by measuring the width of the umbilical tissue approximately 2.5 cm below the umbilical stump. Umbilical cords were dipped using approximately 30 mL of antiseptic solution in a small disposable cup. The umbilical tissue (amnion and umbilical vessels) and umbilical stump (skin, subcutis, and umbilical vessels comprising the portion of the navel cord on the exterior of the abdominal wall) were dipped for approximately 5 s to ensure the umbilical cord opening, tissue, and umbilical stump were thoroughly covered with the antiseptic solution. The calf was weighed (before feeding colostrum), identification tags were placed in both right and left ears, and pasteurized colostrum was fed within 1 h of birth before being moved to the individual calf stalls. The digital caliper was used to measure the umbilical diameter repeatedly at approximately 24 ± 1, 48 ± 1, and 72 ± 1 h after birth. Trained members of the research team who were blind to the treatments performed umbilical cord diameter measurements daily until the remaining external umbilical tissue healed to the point of detachment. University staff veterinarians checked on calves every other day during the trial duration and diagnosed the presence of umbilical infection based on umbilicus stump condition [redness, swelling, painful response to palpation (flinch or kicking), and purulent discharge] and calf health (lack of appetite and fever). Calf age