Short communication: Use of a mechanical brush by Holstein dairy cattle around parturition

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ABSTRACT

Grooming is a normal behavior that may contribute to relief of stress. The purpose of this study was to investigate the effect of access to a mechanical brush on auto-grooming behavior in parturient cows. The hypothesis was that cows would increase the total time spent scratching using the brush if they had access to a brush around the time of calving, whereas auto-grooming would be lower for the brush group compared with the no-brush group. The use of a mechanical brush was analyzed both in a group-housed pen (72 to 48 h before calving) and in an individual maternity pen (6 h before to 6 h after calving) in 16 multiparous Holstein cows. In the maternity pen, cows were randomly assigned to have access to the brush or not. The provision of a mechanical brush in the individual maternity pen did not change the amount of time spent auto-grooming but cows did use the brush before calving and after the calf was removed. Despite being housed in pens containing a brush, cows failed to use it when the calf was present. However, cows with access to a brush spent more time licking their calves in the first hour postcalving ($\beta = 8.7$ min; 95% confidence interval: 1.5, 15.8) than cows that did not have access to a brush. Regardless of treatment, cows increased the time spent auto-grooming and scratching following separation of their newborn calf ($\beta = 1.4$ min; 95% confidence interval: 0.46, 2.3 and $\beta = 0.07$ min; 95% confidence interval: 0.02, 0.12, respectively). Further research is warranted to investigate possible benefits of mechanical brush devices at the time of calving, particularly for cows that experience difficult calving and require manual or mechanical assistance.

Key words: animal welfare, cow comfort, maternal behavior, grooming

Short Communication

Researchers have shown that grooming activity is an innate behavior in most animal species, and grooming one's own body is called auto-grooming (Spruijt et al., 1992). Studies have shown a decrease in auto-grooming in animals when they are sick or in pain (Hart, 1988; Kruk et al., 1998; Anil et al., 2005). Another study has shown an increase in auto-grooming following the injection of adrenocorticotrophic hormone in rats (Van Erp et al., 1994). Cattle put in social isolation or deprived of the ability to lie down increased their auto-grooming frequency (Munksgaard and Simonsen, 1996).

Mid-lactation dairy cows in tie-stalls have been shown to spend, on average, 5 min/d either auto-grooming or scratching themselves against walls and fixtures in a stall (Munksgaard and Simonsen, 1996). Georg and Totschek (2001) concluded that mechanical brushes available in an intensive housing system promoted natural grooming behavior in lactating dairy cattle. DeVries et al. (2007) found that installation of mechanical brushes in freestall pens increased the time spent performing scratching behaviors using the brush in mid-lactation cows, especially in hard-to-reach places by the cow, such as the neck, back, and tail, while decreasing the scratching behavior on pen objects, such as the wall and water trough. It has been suggested that grooming is a way to cope with physiological stress (Spruijt et al., 1992; Van Erp et al., 1994). If so, providing a mechanical brush might help the cow cope with stressors associated with parturition.

Parturition in mammals is associated with a peak in corticotropin-releasing hormone leading to a peak in cortisol levels (Smith, 2007). Elevated corticotropin, adrenocorticotrophic hormone, and cortisol levels have been shown to be associated with increased auto-grooming. It follows that periparturient cattle may demonstrate increased auto-grooming (van Erp et al., 1994; Munksgaard and Simonsen, 1996; Kruk et al., 1998). Evidence suggests that a large proportion of cows perform grooming (self-licking) behavior during the first stage of labor (87% of cows and 70% of heif-

Received August 1, 2012.

Accepted December 30, 2012.

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ers; Wehrend et al., 2006). Providing cows access to a mechanical brush around calving may help to meet a behavioral need.

The suite of maternal behaviors associated with the birth of the newborn calf is extensive, with licking of the calf being one of the most important from the calf's perspective (reviewed by von Keyserlingk and Weary, 2007). To our knowledge, no work to date has addressed the effects of providing cows access to a mechanical brush in the maternity pen on the expression of maternal behavior.

The primary aims of this study were to describe auto-grooming and scratching behaviors in the periparturient period and to determine if provision of a mechanical brush would alter auto-grooming and scratching behaviors on pen objects in the maternity pen. A secondary aim of this study was to determine if access to a mechanical brush in the maternity pen affected licking of the newborn calf, an important maternal behavior.

Twenty-two multiparous (parity = 3.6 ± 1.7 ; mean $\pm$ SD) nonlactating Holstein cows in late pregnancy were enrolled in this study, which was conducted at the University of British Columbia's Dairy Education and Research Centre (Agassiz, BC, Canada). All animals were cared for according to the guidelines of the Canadian Council on Animal Care (2009). All cows entered the prepartum pen at a target of 25 ± 2 d before their expected calving date where they were housed in groups of 12. Each pen contained 12 freestalls with a mattress (Pasture Mat, Promat Inc., Woodstock, ON, Canada) covered with 5 cm of sand bedding. Prepartum cows in the group-housed pens and individual maternity pens were fed twice daily at approximately 0800 and 1600 h. The diet was a TMR provided ad libitum, consisting of 21.3% corn silage, 42.8% alfalfa hay, and 35.9% concentrate and mineral mix on a DM basis (DM: $50.8 \pm 1.2\%$, CP: $14.4 \pm 1.0\%$ of DM, ADF: $35.0 \pm 2.7\%$ of DM, NDF: $45.6 \pm 2.6\%$ of DM, and NE_L : 1.4 ± 0.1 Mcal/kg). In the prepartum pens, cows were fed through a headlock feed barrier, with one headlock per cow spaced at 60 cm on center. Postpartum, cows were fed a TMR consisting of 21.3% grass silage, 14.7% corn silage, 12.3% alfalfa hay, and 51.7% concentrate and mineral mix on a DM basis (DM: $51.1 \pm 1.8\%$, CP: $17.7 \pm 1.0\%$ DM, ADF: $23.7 \pm 1.4\%$ DM, NDF: $36.1 \pm 1.8\%$ DM, and NE_L : 1.7 ± 0.02 Mcal/kg). Pens had vulcanized rubber floors in the alleys and crossovers (Red Barn Dairy Mat, North West Rubber Mats Ltd., Abbotsford, BC, Canada). A mechanical brush (Lely Luna, Lely Industries, NV, Maassluis, the Netherlands) was installed in the alley between the feed bunk and the stalls of the prepartum pen to allow cows to habituate to it. The brush was present at all times for all cows while they were in the prepartum group pen.

At the first signs of imminent calving, such as udder enlargement, milk let-down, relaxation of sacroscopic ligament, and increased restlessness (Huzzey et al., 2005), abdominal contractions, mucus discharge from the vulva, or raised tail, cows were moved to 1 of 2 adjacent individual maternity pens (3.5 by 4.6 m) containing a sand-bedded pack. The 2 maternity pens were each fitted with a mechanical brush identical to those in the prepartum pens. The brushes were located midway along the same side of each pen in such a way that they could be either fixed in place to allow cows within the pen access to the brush or lifted and rotated out of the pen so that they were no longer accessible by the cow housed in the maternity pen. In the latter case, visual contact of the brush was also prevented by completely covering it with a cardboard box. To control for any potential pen effects, we repositioned the brushes within each pen once a week, with the 2 maternity pens always being on alternate treatment (brush versus no brush). Cows were randomly assigned to pens with or without a brush. Animals remained in the maternity pens for 24 h after calving. Calving scores were allocated as 0 = unassisted (eutocia) or 1 = assisted manually (dystocia). Cows that had twins were mechanically assisted with a calving jack, and those that had a Caesarian section were excluded ($n = 3$). Three cows in the brush group were removed from the statistical analyses. For 1 cow, the brush was too high to reach. In the case of the other 2 cows, video footage was missing following calving. Thus, the brush group included 7 cows and the no-brush group included 9.

Behavior of the cows in the precalving pen and maternity pen was recorded using 24-h video surveillance with a wide-angle camera lens (Super Dynamic III Panasonic camera, WV-CP484, <http://www.panasonic.com>), connected to a recording system (UVS 1240E2, GeoVision Inc., USAVisionSys, Irvine, CA). In the prepartum pen, individual animals were identified by their hide pattern, or by previously hair-dyed symbols from another trial 2 to 3 mo before this trial, to determine if they used the brush (and if the habituation to the brush was successful, by using the brush for at least 1 min continuously). Brush use was defined when the cow first touched the brush until the cow moved away, no longer touching the brush. The total time spent using the brush during the period from 72 to 48 h before calving (defined based on the actual time of delivery of the calf) was determined from video. In the maternity pen, video was used to measure auto-grooming (i.e., self-licking), rubbing/scratching (when the cow rubbed against the walls or fixtures of the pen, i.e., pen objects), and the use of the mechanical brush (when it was present in the pen). The periods while cows were housed in the maternity pens during which the auto-

grooming, rubbing/scratching, and brush use (when available) behaviors were recorded for approximately 6 h before and 6 h after calving and were categorized into 3 periods: precalving (351 ± 38 min; mean $\pm$ SD), postcalving with the calf present (98 ± 62 min), and postcalving after removal of the calf (180 ± 59 min). The time spent away from the maternity pen for milking during the postcalving period was removed from the relevant time period, and behaviors were expressed as minutes per hour in each period.

All analyses were performed with STATA Intercooled 10.1 (StataCorp, College Station, TX). Mixed linear regression models were used to determine the effect of the brush for the precalving, postcalving with calf, and postcalving without calf time periods for the following dependent variables: auto-grooming behavior and scratching/rubbing behavior, with the following independent categorical variables offered to the model: treatment (brush vs. no brush) and time (precalving period, postcalving with calf, and postcalving without calf). A mixed linear regression model was also used to examine brush use in the maternity pen for the cows that had access to a brush, for the periods of precalving, postcalving with calf, and postcalving without calf. A linear regression model of time spent calf licking during the first hour postcalving was used to identify any treatment effects (i.e., brush vs. no brush) while in the maternity pen. The animal was considered as the experimental unit and was included as a random intercept in mixed regression models to account for repeated measures. All tests were 2-sided and significance was based on $\alpha < 0.05$. Interactions between treatment and period in the final model were tested. Standardized residuals were examined to verify model assumptions of normality and homoscedasticity, and to identify outliers at the observation-level for both linear and mixed linear regression models, and BLUP were examined to identify any outliers at the cow level for mixed linear regression models. Normality and homogeneity of variance were assessed for the observation-level standardized residuals and the BLUP for the mixed models.

When in the group precalving pen, all cows made use of the mechanical brush on average 31.5 ± 17.7 (mean $\pm$ SD) min/d in the 72 to 48 h before calving. This study was the first to describe brush use by Holstein cows around the time of calving, which was much greater than the 5 to 7 min/d reported for mid-lactation dairy cows (DeVries et al., 2007).

No differences were noted in the amount of time spent auto-grooming in the maternity pen in the periods before and after parturition (when the calf was present), with cows spending approximately 0.86 min/h (± 0.77 SD) and 0.67 min/h (± 1.0 SD) engaged in these behaviors, respectively (Table 1, Figure 1A). However,

auto-grooming increased to 2.3 min/h (± 2.3 SD) following removal of the calf from the pen (Table 1, Figure 1A). The amount of time spent scratching/rubbing on pen objects was not different between the brush and no-brush treatment groups over the 3 time periods (Table 1, Figure 1B). Clearly, we were not able to control for the visual presence of the brush in the adjacent pen of the cows in the no-brush treatment group. However, given that we were unable to detect any differences in auto-grooming between the 2 treatment groups in auto-grooming and scratching on pen objects, we feel that the visual presence of the brush in the adjacent pen likely did not have a major effect on our results.

Munksgaard and Simonsen (1996) reported that mid-lactation cows spend, on average, 5 min/d auto-grooming, scratching, or both. Our study is the first to describe auto-grooming and scratching in calving cows, and time budgets may be quite different between mid-lactation and calving animals. It is noteworthy that these rare behaviors have only been reported in a limited number of studies to date (e.g., Munksgaard and Simonsen, 1996). Unfortunately, the limitations of our study (as with the previous work) prevent us from providing any insights as to whether this limited amount of time spent engaged in these behaviors is biologically relevant. We therefore strongly encourage future work to investigate the motivation for cows to engage in these behaviors as this will provide additional insights into their biological relevance.

In the period before calving, cows spent approximately 0.15 min/h (± 0.10 SD) scratching/rubbing themselves. However, virtually no scratching/rubbing behaviors were observed in cows while the calf was present (Table 1, Figure 1B). In the hours immediately following removal of the calf from the pen, cows increased scratching/rubbing time to 0.08 min/h (± 0.07 SD; Table 1, Figure 1B). However, the time spent scratching/rubbing failed to return to the level observed during the precalving period (Table 1, Figure 1B). The time spent scratching/rubbing precalving, as well as postcalving without the calf present, was greater than that previously reported by DeVries et al. (2007). A possible explanation for this difference is that DeVries et al. (2007) observed mid- to late-lactation cows, whereas the cows used in the present study were parturient cows. It could be argued that the cows in the present study had higher stress levels due to the active stages of calving (Smith, 2007), which may have resulted in an increase in scratching behavior (Neary and Hepworth, 2005; Wehrend et al., 2006; Smith, 2007).

It would appear that the maternal behavior of calf licking took precedence over the cow's auto-grooming and scratching/rubbing. Auto-grooming by the dam increased immediately following calf removal. This

Table 1. Mixed linear regression models with model coefficient β , P -value, and 95% CI for the time spent in grooming behaviors (min/h) for 16 Holstein cows randomly assigned to have access to a mechanical brush in the calving pen

Variable	Auto-grooming (n = 16 cows)				Scratching/rubbing (n = 16 cows)				Brush use (n = 7 cows)			
	β	P -value	95% CI	Variance	β	P -value	95% CI	Variance	β	P -value	95% CI	Variance
Treatment												
Brush	0.08	0.89	−1.0, 1.2		−0.02	0.38	−0.07, 0.03		—	—	—	
No brush	Ref. ¹				Ref.				—			
Time ²												
Precalving	Ref.				Ref.				Ref.			
Postcalving, with calf	−0.18	0.68	−1.1, 0.70		−0.15	<0.001	−0.20, −0.10		−0.41	0.11	−0.90, 0.09	
Postcalving, no calf	1.4	0.003	0.46, 2.3		−0.08	0.004	−0.13, −0.03		−0.01	0.98	−0.52, 0.51	
Intercept	0.90	—	−0.06, 1.9		0.14	—	0.10, 0.19		0.50	—	0.15, 0.84	
Random intercept												
Cow level			0.39, 1.7	0.64			4.9E−17, 1.2E−08	5.7E−25			6.4E−16, 0.02	1.5E−17
Observation level			0.99, 1.7	1.6			0.06, 0.09	5.6E−3			0.34, 0.66	0.22

¹Referent.

²Time periods: precalving (−6 h to calf on the ground), postcalving with the calf present (mean 98 ± 15 min), and postcalving without the calf (mean 180 ± 14 min).

Figure 1. Observed average ($\pm$ SE) for (A) auto-groom behavior (min/h), (B) scratching/rubbing on pen wall behavior (min/h), and (C) brush use (min/h) by treatment group around calving [precalfing = −6 h to calf on the ground; postcalving with calf = from calf on the ground until calf was removed from the pen (98 ± 15 min); postcalving without calf to 6 h = from when the calf is removed until 6 h after calving (180 ± 14 min)] while cows were housed in the individual maternity pen with and without access to the brush. *Difference ($P < 0.05$) from the precalfing period; †difference ($P < 0.05$) from the postcalving with calf period.

increase in auto-grooming behavior after cow-calf separation has been reported previously by Houwing et al. (1990), when the calf was removed at approximately 10 h postpartum. Behavioral changes following cow-calf

separation are well established and include increasing vocalization and activity (Hudson and Mullord, 1977; Lidfors, 1996; Flower and Weary, 2001). Thus, the results observed in this study were not surprising. The increases in auto-grooming for the remaining 3 h of observations following calf removal may be in response to the acute stress arising from the removal of the calf. Hudson and Mullord (1977) investigated the influence of time spent together by the cow and her calf immediately following parturition on the establishment of the maternal bond through licking. They showed that just 5 min of contact immediately after birth resulted in the formation of a maternal bond that was strong enough to withstand 12 h (but not 24 h) of separation.

The current study examined the effects of having a brush versus no brush for cows housed in an individual maternity pen on scratching and auto-grooming behaviors before and after calving. When given access to a brush around calving, cows used the brush both before and following calving (Table 1; Figure 1C). Although we observed no effects of having a brush on auto-grooming or on scratching/rubbing behavior, interestingly, cows that had access to a brush spent more time engaged in calf licking behavior during the first hour after parturition compared with the cows who calved in maternity pens without a brush ($\beta = 8.7$ min; $P = 0.02$; 95% CI: 1.5, 15.8; observed average brush = 43 min $\pm$ 10 SD and no brush = 31 min $\pm$ 13 SD). A possible explanation for the increase in calf licking for the brush group was that using the brush to scratch themselves resulted in an increase in oxytocin levels. It has been shown that stroking the back of rats significantly increased plasma levels of oxytocin (Stock and Uvnäs-Moberg, 1988). Furthermore, it has been suggested that oxytocin plays a role in pair-bonding behavior of mammals (Uvnäs-Moberg, 1996), and thus, brush use in this study may have facilitated the licking of the calf and aided in the establishment of the maternal bond (for review, see von Keyserlingk and Weary, 2007). Alternatively, the increased licking of the calf may have provided an analgesic effect through the increased likelihood of amniotic fluid intake from the calf (Pinheiro Machado et al., 1997).

Future work should investigate a brush versus no-brush group for longer periods before and after calving, particularly in the case of cows that experience difficult deliveries and might have a higher level of stress due to the effects of dystocia. Unfortunately, the present study included too few cows with dystocia to evaluate the effects of dystocia. The fact that the brush caused an increase in maternal behavior (greater calf licking time in the first hour following calving), compared with animals without access to a brush, warrants further investigation.

ACKNOWLEDGMENTS

The authors thank all of the staff and student support at the University of British Columbia Dairy Education and Research Centre (Agassiz, BC, Canada), particularly Gosia Zobel for her help with the video equipment. Mechanical brushes were donated by Lely Industries (Maasluis, the Netherlands). The first author was funded by a Natural Sciences and Engineering Research Council Industrial Post-Graduate Scholarship II with Boehringer-Ingelheim Canada Ltd. (Burlington, ON, Canada) as the industrial partner. The UBC Animal Welfare Program is funded through NSERC's Industrial Research Chair program, with industry contributions from the Dairy Farmers of Canada (Ottawa, ON, Canada), Westgen Endowment Fund (Milner, BC, Canada), Pfizer Animal Health (Kirkland, QC, Canada), BC Cattle Industry Development Fund (Kamloops, BC, Canada), the BC Milk Producers (Burnaby, BC, Canada), BC Dairy Foundation (Burnaby, BC, Canada), BC Dairy Education and Research Association (Abbotsford, BC, Canada), and Alberta Milk (Edmonton, AB, Canada).

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