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BRIEF COMMUNICATION: An investigation of automated measures for assessing pain-induced distress in dairy calves

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Introduction

Dairy calves are routinely disbudded using hot-iron cautery without pain relief in New Zealand, and studies have shown this procedure causes physiological and behavioural changes indicative of pain (Stafford & Mellor, 2011). To evaluate the effectiveness of different pain mitigation strategies during routine husbandry procedures (e.g., disbudding), intensive physiological and/or behavioural studies are needed. The limitations of these measures are that the methods (e.g., blood sampling) can cause animal stress and analysis of behaviour video recordings is labour intensive. Automated, non-invasive measures of behaviour are now available, such as feeding behaviour provided by automatic calf feeding systems (ACF) and activity, recorded using accelerometers (e.g., Hobo data loggers). Feeding and lying behaviours are altered in calves in response to stress and/or pain during procedures such as hot-iron cautery disbudding (Graf & Senn, 1999; Bates et al. 2015). It is well documented that this procedure causes significant pain. Therefore, the aim of this study was to determine if behavioural data collected from ACF and Hobo data loggers could be used as an indicator of pain-induced distress in dairy calves.

Materials and methods

Fifty-one female Friesian-cross dairy calves (48.5 ± 4.76 kg) were used in this study, which was conducted on AgResearch's Tokanui Dairy Research Farm in South Waikato, New Zealand. All procedures involving animals were approved by the Ruakura Animal Ethics Committee under the New Zealand Animal Welfare Act 1999.

Calves were kept in pens with woodchip bedding and provided with water, hay and pellets (Calf-pro1 20%, Seales Winslow, Morrinsville, NZ) *ad libitum*. An ACF (A&D Reid, Temuka, NZ) with an electronic ID system was used to provide whole milk, delivered to calves at a temperature of 22-25°C. Each calf was permitted a total allowance of 6 L/d: 2 L three times daily with a minimum withholding period of 400 min between each feed.

At approximately three weeks of age, calves were allocated to one of five treatment groups: 1) sham handling (SHAM; n = 10), 2) hot-iron cautery disbudding (DB; n = 11), 3) DB + administration of local anaesthetic (DB+LA; n = 11), 4) DB + administration of a non-steroidal anti-inflammatory drug (DB + NSAID; n = 9) and 5) DB + LA + NSAID (n = 10). Calves were restrained in a calf crush with a head bail during treatments. An electric cautery iron ("Quality" electric debudder, 230 V, 190 W; Lister GmbH, Lüdenscheid, Germany) was used to remove calf horn buds. Local anaesthetic (2% lignocaine hydrochloride; Lopain, Ethical Agents Ltd., Auckland, NZ) administration involved injecting Lopain into the corneal nerve (3 mL) and five injection sites around the base of the horn bud (0.2 mL/site) 5 min prior to disbudding. Immediately prior to disbudding, a needle prick test was used to verify the success of the cornual nerve block. For NSAID treated calves, Meloxicam (0.2 mg/kg; Metacam, Boehringer Ingelheim Ltd., Auckland, NZ) was injected subcutaneously 5 min prior to disbudding.

Feeding and lying behaviour were recorded continuously for 24 h before and 48 h after treatment. Frequency of rewarded and unrewarded visits and milk volume was automatically recorded by the ACF. Lying times and number of lying bouts were recorded using Onset Pendant G data loggers (64k, Onset Computer Corporation, Bourne, MA, USA) fitted to the hind leg.

Statistical analysis

All data was analysed using Genstat and SAS. A mixed-effects model was used to analyse total milk consumption, frequency of daily visits to the milk feeder (rewarded and unrewarded), number of lying bouts and proportion of time spent lying over three time periods: pre-treatment (24 h immediately preceding the time of treatment), 24 h from the time of treatment (24 h) and 24 to 48 h following the treatment (48 h). Fixed components for all analyses included treatment, and random variables included replicate. Statistical significance for all results was set at $P \leq 0.05$.

Results and discussion

The total number of visits, rewarded visits, unrewarded visits and milk volume consumed was similar among all treatments during the 24-h period prior to administration of treatments and the 24 to 48 h post-treatment period (Table 1). During the 24-h post-treatment period, milk volume consumed was similar among SHAM and calves disbudded, with or without pain relief. In contrast, Bates et al. (2015) found that mean cumulative milk consumption over the 11-d post-disbudding period was greater for calves disbudded with pain relief compared to those without.

Table 1 Feeding and lying behaviour of calves pre-treatment (24 h immediately preceding the time of treatment), 24 h from the time of treatment (24 h) and 24 to 48 h following the treatment (48 h). Sham handling (SHAM; n = 10), 2) cautery disbudding (DB; n = 11), 3) DB + administration of local anaesthetic (DB+LA; n = 11), 4) DB + administration of a non-steroidal anti-inflammatory drug NSAID (DB + NSAID; n = 9) and 5) DB + LA + NSAID (n = 10).

	Treatments					
	SHAM	DB	DB+LA	DB+ NSAID	DB+LA+ NSAID	SE
Feeding behaviour						
Total milk consumed (L)						
Pre-treatment	4.3	4.9	4.7	4.8	5.0	0.60
24 h	6.1	5.6	5.8	5.7	6.1	0.23
48 h	6.3	5.2	5.6	5.3	5.3	0.32
Total visits (no.)						
Pre-treatment	6.4	5.7	6.6	6.7	6.3	1.88
24 h	8.4[b]	5.1[a]	4.6[a]	6.1[c]	6.8[bc]	0.98
48 h	9.0	6.3	6.0	7.5	6.4	1.26
Rewarded visits (no.)						
Pre-treatment	2.4	3.1	3.7	3.5	2.8	0.73
24 h	3.4	3.0	3.1	4.1	3.4	0.36
48 h	3.4	3.1	3.2	3.3	3.2	0.34
Unrewarded visits (no.)						
Pre-treatment	3.9	2.6	2.9	3.1	3.5	1.44
24 h	4.9[b]	2.1[c]	1.5[a]	2.0[c]	3.4[bc]	0.88
48 h	5.7	3.3	2.9	4.3	3.3	1.32
Lying behaviour						
Time spent lying (%)						
Pre-treatment	35.0	39.9	35.0	36.1	41.6	2.39
24 h	41.9	41.6	42.3	39.3	41.4	1.80
48 h	39.8	39.9	39.5	38.2	39.9	1.82
Lying bouts (no.)						
Pre-treatment	18.2	18.6	18.1	18.8	17.4	1.53
24 h	11.9	15.8	16.4	14.4	15.0	1.53
48 h	20.0	21.5	19.8	21.3	19.2	1.51

Therefore, it is possible that if we had recorded milk volume consumed for a longer period of time that treatment differences could have been detected. Furthermore, milk allowance is an important factor to consider when using total volume consumed as an indicator of distress (e.g., pain or disease) and in New Zealand, calves are commonly provided with a low milk allowance. Borderas et al. (2009) found that sick calves consumed less milk at an ACF when provided with a high milk allowance in comparison to healthy calves, but when they were provided with a low milk allowance, total milk consumption was not affected.

SHAM calves visited the ACF more ($P < 0.05$) during the 24-h post-treatment period than DB, DB+LA and DB+NSAID calves. There was no difference in the number of rewarded visits to the ACF, however SHAM calves had more ($P < 0.01$) unrewarded visits during the 24-h post-treatment period than DB, DB+LA and DB+NSAID calves. These results suggest that even though there was no difference in the amount of milk consumed among treatments, calves that were not disbudded were more motivated to visit the ACF than calves disbudded with LA or NSAID, or without pain relief. Fewer unrewarded visits to the ACF by disbudded calves could reflect a lack of appetite in these animals due to the pain and/or distress caused by disbudding. Similarly, Svensson & Jensen (2007) found that the number of unrewarded visits to an ACF was a more sensitive indicator of disease in calves fed restricted milk volumes. It is also possible that disbudding caused these calves to become head shy, hence, more hesitant to place their heads in the ACF due to the potential risk of knocking their head in the confined space.

The number of visits to the feeder and the number of unrewarded visits to the ACF during the 24-h post-treatment period was similar between SHAM and DB+LA+NSAID calves, however, feeding behaviour was similar among DB+LA and DB+NSAID and calves disbudded without pain relief. These results suggest that LA+NSAID was the most effective pain mitigation strategy evaluated in the present study, which is in agreement with physiological studies showing that giving calves LA in combination with an NSAID prior to disbudding eliminates the cortisol response to this procedure and is more effective than using LA or NSAID separately (Stafford & Mellor, 2011).

The proportion of time spent lying and the number of lying bouts performed by calves was similar among all treatments groups (Table 1). In contrast, McMeekan et al. (1999) found that calves spent less time lying during the 4-h period post-dehorning, however, dehorning was performed on older calves which is likely to elicit a greater stress response than disbudding (Stafford & Mellor, 2011) so may have a greater impact on calf behaviour. In conclusion, the number of visits (total and unrewarded) to the ACF appeared to be a more sensitive measure of pain-induced distress in calves than automated measures of lying behaviour. Furthermore, automated feeding behaviour data may be more useful for assessing pain-induced distress in calves in systems where higher milk allowances are provided.

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