Assessment of vigour in early life of dairy calves in New Zealand

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Abstract

Vigour of dairy calves in the first few days of life may be a relevant predictor of subsequent performance in an artificial-rearing system. This experiment aimed to evaluate two scoring systems to determine whether they detected variation in beef-sired calves born in the New Zealand pastoral dairy system. The scoring systems included a vigour score devised for housed dairy calves in Canada which had a range of physical and physiological parameters assessed, and a drinking score assessed at the feeder in the first few days of life (1=calf does not attempt to suck on feeder, 5=calf drinks vigorously for the whole feed). Calves generally scored highly (17-21 out of a possible 22 points) on the vigour score and meconium staining, head/tongue swelling, movement and heart rate showed little to no variation among calves. The drinking score showed that few calves scored in the low categories, and the scoring system may be improved by creating greater separation within the higher categories. Angus-cross calves were more likely to have a higher drinking score than Hereford-cross calves, and light or young calves were more likely to have low drinking scores.

Keywords: calves; drinking; vigour

Introduction

Calves born in New Zealand dairy herds face a number of challenges in early life. Typically born in late winter or early spring, they are often born in inclement weather conditions. After routine removal from their dams within 24 hours of birth, calves are typically housed and either artificially reared on-farm, sold for rearing elsewhere at 4-7 days of age, or sent for processing at four days of age. The mortality rates of calves reared on-farm are in the range of 5.7% perinatally, and 4.1% from 24 h to weaning at 13 weeks of age (Cuttance et al. 2017). Additionally, 2% of calves presented for processing at bobby-calf facilities are in marginal or unacceptable condition (Fisher et al. 2017). Some 17.5–42% of calves born in dairy herds may not have received adequate colostrum (Wesselink et al. 1999, Coleman et al. 2015), leading to increased likelihood of death prior to weaning (Faber et al. 2005).

Vigour refers to the physical strength of the calf, and capacity for growth and survival. Vigour of the calf at birth is likely to be a contributing factor to whether the calf will receive colostrum from its mother, and its suitability for rearing or processing. Murray et al. (2015) adapted the Apgar scoring system for human babies to create a vigour score for dairy calves in an indoor calving system in Canada, and similar scores have previously been adapted for piglets, puppies and foals (Veronesi et al. 2009). Such scoring systems require assessment of the neonate within the first few minutes after birth, so are impractical to implement in the outdoor-calving New Zealand system. An assessment of vigour that can be applied to young calves in the shed may be preferable under New Zealand conditions.

Vigour of the calf can be compromised by a difficult birth, and indicators of birth difficulty including swelling of the head or tongue, and meconium staining, may be included in vigour assessment for this reason (Murray et al. 2015). Environmental conditions, such as cold temperature or being born at night may also influence vigour behaviours (Wesselink et al. 1999, Diesch et al. 2004).

Therefore, the aim of this experiment was to determine whether either a modified version of Murray's (2014) Canadian vigour score or an in-shed drinking score were able to detect variability in vigour of dairy calves in New Zealand, and to determine whether an in-shed drinking score was related to birth weight and age of calves.

Materials and methods

Animals

Beef-cross calves born to 28 Hereford and 28 Angus sires in the 800-cow commercial dairy herd at Limestone Downs at Port Waikato, New Zealand in the 2016 spring calving season were used, with approval from the Massey University Animal Ethics Committee. Cows and heifers in the herd were predominantly Friesian and Friesian-Jersey crossbred. Each day during the calving period, calves born in the previous 24 hours were moved from the calving paddock to a shed with river stones for flooring at approximately 10 am. Calves were fed twice daily from a fence-mounted artificial feeder, beginning on the afternoon of arrival in the shed. Calves were offered *ad libitum* first-milking colostrum for the first two feeds, and 2 L per calf per feed of stored surplus colostrum and milk thereafter. For the first 24 hours in the shed, calves were kept separate from older calves, then grouped into pens of 10 calves of approximately similar ages, after their second feed.

The first experiment included 77 calves born to multiparous, mixed-aged dairy cows. Observation periods were from 1-6 pm on 17 occasions between 17th July and 9th August 2016, and calves born alive after an unassisted birth during each observation period were included in the experiment. Thirty calves were Angus-sired and 47 were Hereford-sired.

The second experiment included 345 Angus- and Hereford-cross dairy calves out of multiparous, mixed-aged cows and first-lactation two-year-old heifers. These calves were observed on one of four occasions. This experiment included 60 of the calves from the first experiment, and calves were selected based on the number of pens the observer could follow during the feed.

Measurements

All measurements and observations were made by the same observer.

In the first experiment, parturition was observed and time of birth was recorded. In the first hour after birth, visual observations were made, each on a scale of 0 to 3, of meconium staining (0=completely covered in meconium staining; to 3=no staining) and head/tongue swelling (0=head and tongue swollen, tongue protruding; to 3=no swelling, tongue not protruding), and initiation of movement (0=still lying on side after 3 hours, no attempts to rise; to 3=standing within 30 minutes of birth) (Murray 2014).

After the calf had suckled from its dam for the first time, or at 1 hour post-partum for calves that did not suckle in this time window, calves were manually restrained for up to two minutes for further measurements (Murray 2014). Measurements included placing a finger in the calf's mouth to score the sucking reflex (0=no response; to 3=strong suck), testing head shake response to sticking a small piece of grass 3 cm into the calf's nostril (0=no response; to 3=vigorous head shake), lifting the upper lip to view the colour of the oral mucous membranes (0=white/blue; to 3=bright pink), and establishing heart (HR) and respiratory rates (RR). Heart rate and RR were each assigned a score on the scale of 0 to 2, where 0 was slow HR (<80 bpm) or fast RR (>36 rpm), 1 was fast HR (>100 bpm) or slow RR (<24 rpm) and 2 was normal for each (80-100 bpm HR, or 24-36 rpm RR). All calves were standing within 30 minutes of birth, allowing initiation of movement to be scored as well. Overall vigour score was calculated as the sum of the component scores.

In the second experiment, 345 calves aged between two and nine days of age were observed during a routine feeding event. Each calf was observed on one occasion only. Calves were fed in their groups of 10, on a 10-teat, non-compartmentalised, portable feeder (Milk Bar, Waipu NZ). During feeding, each calf was assigned a drinking score: 1=calf does not attempt to suck on feeder, 2=calf sucks on feeder intermittently and frequently falls off the teat requiring assistance to get back on, 3=calf initially feeds well but then retreats from feeder or falls off the teat frequently, 4=calf drinks with vigour but falls off or is displaced from the teat at least three times during the feed, 5=calf drinks vigorously for the whole feed. Drinking scores were also grouped into "good drinkers" (score 4 or 5) and "poor drinkers" (score 1-3) on the basis that calves that scored 1-3 were unlikely to have consumed their share of the milk offered.

Date of birth, breed and sex of calf were recorded and calves were weighed on entry to the calf shed. Parentage was assigned using DNA using a commercial SNP parentage panel (Zoetis, Dunedin). Gestation length was calculated for calves for which the dam had a recorded insemination to the relevant sire.

Statistical methods

Vigour-score parameters were analysed using a generalised linear model. For parameters that had values assigned in only two of the possible scores, a binomial distribution was assumed. For parameters with values assigned in three scores within the scale, a Poisson distribution was assumed. All models included the fixed effects of sex and breed. Gestation length, birth weight and date of birth were considered as covariates but these were not significant and were removed from the models. Heart rate, RR and overall vigour score were analysed using a general linear model allowing for the fixed effects of sex and breed. Date of birth, gestation length and birth weight were considered as covariates in these models, but were non-significant and removed, with the exception that date of birth was significant in the model for overall vigour score.

Drinking score was analysed using a generalised model assuming a Poisson distribution for the 1-5 scale and a binomial distribution for good versus poor drinkers. The models for drinking score included the fixed effects of breed and sex and the covariate of age at observation and birth weight.

Results

The majority of calves (90%) achieved a score of between 17-21 on the 22-point vigour score (Figure 1). Most calves showed no head/tongue swelling (score 3, 97%), and all calves stood within 30 minutes (scored 3 for movement). Scores for sucking reflex, head-shake response and colour of mucous membranes ranged from 1 to 3 (Table 1), but most calves scored 2 or 3 for these parameters, indicating good vigour. Heart rate was fast (score 1), whilst RR was normal (score 2) for most calves.

Figure 1 Distribution of vigour scores of beef-cross-dairy calves (n=77) assessed within the first hour after birth. Possible scores ranged from 0 to 22.

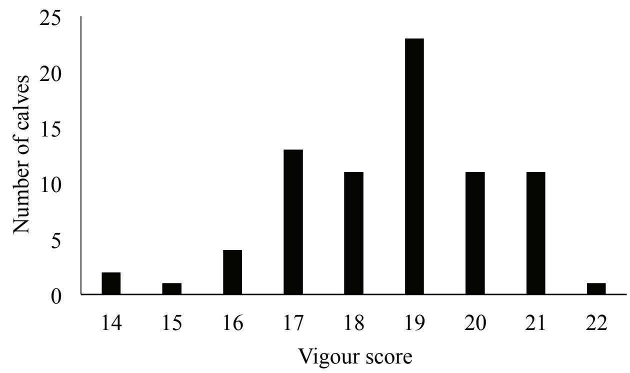


Table 1 Percentage of beef-cross-dairy calves (n=77) in each score category for each component of vigour score assessed in the first hour after birth (in general, 0=poor, 3=good).

	0	1	2	3
Meconium staining	0	0	14	86
Head/tongue swelling	0	0	3	97
Movement	0	0	0	100
Sucking reflex	0	12	43	45
Head-shake response	0	14	60	26
Colour of mucous membranes	0	8	19	73
Heart-rate[1]	0	99	1	-
Respiratory rate[1]	5	19	75	-

[1]Heart rate and respiratory rate were scored on a 0-2 scale.

Table 2 Percentage of beef-cross-dairy calves by breed in each category for drinking score assessed at feeding from a 10-teat portable feeder at two to 9 days of age (1=poor, 5=excellent).

	n	1	2	3	4	5
Angus-sired calves	160	0	0.6	3.1	60.0	36.3
Hereford-sired calves	185	0	1.6	14.1	51.9	32.4

Meconium staining was greater (P=0.017) in Hereford-cross than in Angus-cross calves: 21% (95% CI 12-35%) of Hereford-cross calves scored 2 (light staining) compared with 3% (95% CI 0-20%) of Angus-cross calves. All other calves scored 3 (no staining). There was no effect of breed or sex on sucking reflex, head-shake response, colour of mucous membranes, HR or RR (data not shown). Similarly, overall vigour score was not affected by breed or sex. There was no effect of birth weight or date of birth on any of the parameters assessed.

Overall vigour score was greater (P=0.002) for Angus-sired (19.3, 95% CI 18.8-19.9) than for Hereford-sired calves (18.2, 95% CI 17.8-18.6). Furthermore, overall vigour score was greater (by 0.13 units per day, P<0.001) for calves born late in the season.

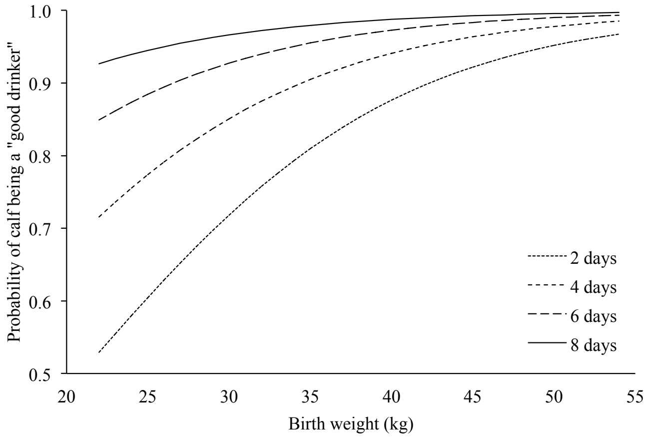
The majority of calves achieved 4 or 5 for drinking score, and no calves scored 1 (Table 2). There was no effect of age, sex or breed on drinking score when assessed on a five-point scale, however, when scores 4-5 were grouped as "good drinkers" and scores ≤3 were grouped as "poor drinkers", more Angus-sired calves than Hereford-sired calves were good drinkers (98%, 95% CI 94-99% versus 88%, 95% CI 82-93%; P<0.001).

Mean birth weight was 36.5 kg (SD 4.7 kg). The percentage of calves that were good drinkers increased with age (P<0.001) and with birth weight (P=0.025; Figure 2). Gestation length was known for 209 calves, but for this subset of calves, neither gestation length nor birth weight influenced drinking score (data not shown).

Discussion

The calves in this study demonstrated generally very good vigour immediately after birth. The calves were quicker to stand after birth compared with Canadian dairy calves born indoors in a straw-bedded pen (Murray et al. 2015), Angus calves born to primiparous heifers at pasture in New Zealand (Hickson et al. 2008) or dairy calves born at pasture in New Zealand (Diesch et al. 2004). Similarly, the calves in the present experiment also had a stronger sucking reflex than Canadian dairy calves (Murray et al. 2015). The calves in the present experiment also had excellent scores for meconium staining, head/tongue swelling, colour of mucous membranes and respiratory rate. These results indicate that calves born unassisted during the afternoon observation period in this dairy herd were not likely to be suffering from impaired vigour. The rate of obstetrical assistance was <1% in this herd, indicating that many of the calves were likely to have experienced an easy birth.

Figure 2 The probability of a calf being a "good drinker" (drinking score 4 or 5 out of 5) at two, four, six or eight days of age, in relation to its birth weight.



There was very little variation in head/tongue swelling, movement and heart-rate score, indicating that these measurements were not useful in detecting subtle differences among vigorous calves. This experiment was limited to calves born in the afternoon, and greater variation in vigour may have been observed if calves born into more challenging, cold conditions in the night or early morning had been included. Diesch et al. (2004) reported a significant negative correlation between air temperature and time to stand after birth, and Wesselink et al. (1999) reported calves born in the night took longer to stand than calves born during the day, indicating that the selection of only afternoon-born calves may have increased the mean vigour score of the calves.

More Hereford-sired calves than Angus-sired calves scored 2 for meconium staining. There were no breed differences in any other vigour traits, so it is likely that the presence of meconium may have been similar between groups, but that light meconium staining was not detectable on the black coat of the Angus-sired calves. In contrast, the white head and legs of the Hereford-cross calves made it easier to detect small variations in colour. Therefore, assessment of meconium staining should be limited to breeds with areas of white on the coat.

In-shed drinking score was consistent with the vigour score, in that most calves scored very highly. The majority of calves scored 4, and further division of this category may have been useful. For example, distinguishing between calves that were displaced from the teat by other calves and those that dropped off the teat by themselves may have been relevant. Nevertheless, the drinking score demonstrated that lighter calves were less likely to be good drinkers, and this difference was exacerbated for younger calves. The drinking score improved with age for calves at all birth weights, but the heavier calves were relatively good drinkers from as young as two days of age.

In their study on Friesian bulls, Muir et al. (2002) suggested that calves of at least 40 kg should be selected for rearing in bull-beef systems. However, the focus on easy calving and low-birth-weight bulls has meant that many beef-cross-dairy calves are below this weight (77% of calves in this experiment weighed less than 40 kg at birth). For calves in the 30-40 kg birth weight range, the substantial increase with age in the probability of being a good drinker indicates that such calves would benefit from intensive supervision at feeding until they are at least eight days of age. The definitions of the drinking score used here mean that calves that were poor drinkers were spending time not feeding, and in situations of competitive milk consumption (i.e. where there is insufficient milk provided for all calves to drink to satiety), these calves are at risk of receiving a lesser amount of milk.

Neither the vigour score nor the drinking score showed sufficient variability or ability to detect subtle differences among vigorous calves, which would be necessary for these scores to have value to in a research setting, where such scores could be used to determine the impact of various treatments on vigour of calves. Sucking reflex, head-shake response and colour of mucous membranes showed more variation than the other parameters in the vigour score, so may be the most useful in the New Zealand situation.

Drinking score was straight-forward to implement in New Zealand calf-rearing systems, and showed variation among calves. Further refinement of this score to allow greater division of calves currently grouped into category 4 would increase the ability to distinguish between more and less vigorous calves. Assessment of drinking score at a fixed age would enhance the ability to compare among calves. We suggest Day 2 or 3 would be suitable, and show the most variation, and therefore be most likely to discriminate among calves' drinking ability.

In conclusion, dairy calves born unassisted at pasture in the afternoon were vigorous and did not display sufficient variation in vigour to warrant vigour scoring. In-shed drinking score increased with age and with birth weight, and fewer lighter calves than heavier calves were good drinkers at any age.

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