Effects of transportation duration on lying behavior in young surplus dairy calves

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ABSTRACT

Surplus dairy calves are commonly transported long distances from dairy farms to calf-raising facilities and livestock auctions. Current calf transportation research mainly describes physiological changes resulting from transportation. However, few studies have described the effects of transportation on calf behavior. The main objective of this study was to determine the effects of different durations of transportation (6, 12, and 16 h) on lying time and bouts in surplus dairy calves. A secondary objective of this study was to investigate whether calf age affected lying behavior around transportation.

Surplus dairy calves (n = 175) were transported in 7 cohorts from 5 commercial dairy farms in Ontario to a single veal facility. On the day of transportation (d 0), calves were randomly assigned to 1 of 3 treatment groups: (1) 6 h (n = 60), (2) 12 h (n = 58), or (3) 16 h (n = 57) of continuous transportation by road. Calf lying and standing behaviors were recorded using HOBO data loggers (Hobo Pendant G Acceleration Data Logger, Onset Computer Corporation). Daily lying time (h/d) and bouts (no./d) were assessed from −1 to 3 d relative to transportation. The total time spent lying during transportation was assessed as the percentage of time lying (min lying/total min on the trailer × 100) from the time each calf was loaded onto the trailer until the time each calf was unloaded at the veal facility (n = 167). On the day of transportation (d 0), calves transported for 12 and 16 h spent less time lying (6 h: 17.1 h/d; 12 h: 15.9 h/d; 16 h: 15.0 h/d) and had more lying bouts (6 h: 21.9 bouts/d; 12 h: 25.8 bouts/d; 16 h: 29.8 bouts/d) compared with those transported for 6 h. On the day after transportation (d 1), calves transported for 16 h spent more time lying down than calves transported for 6 h (19.9 h/d vs. 18.8 h/d, respectively). In addition, during transportation, calves transported for 12 h and 16 h spent 5.8% and 7.6% more time lying down, respectively, than calves transported for 6 h. On each day relative to transportation (d −1 to 3), younger calves (2 to 5 d of age) spent a greater amount of time lying down than older calves (6 to 19 d of age) and, overall, had a greater number of lying bouts. The results of this study suggest that longer durations of transportation influence the lying behavior of surplus dairy calves, resulting in more fatigue during and after the journey and, therefore, potentially have negative implications for calf welfare. Additionally, longer durations of transportation may have greater influence on younger calves than older calves.

Key words: surplus calves, transportation, lying behavior, veal

INTRODUCTION

“Surplus dairy calf” is a term for calves born on dairy farms that are undesirable as milking herd replacements. These calves can be transported up to 1,300 km from dairy farms to calf-raising facilities (reviewed by Creutzinger et al., 2021) to be reared for veal or dairy-beef at 3 to 7 d of age (Wilson et al., 2020; reviewed by Roadnight et al., 2021). Several factors related to transportation can affect a calf’s behavior and activity. For example, during transportation, calves experience feed and water withdrawal, which can potentially lead to hunger (reviewed by Roadnight et al., 2021) and dehydration (Knowles et al., 1997). Inadequate space allowance due to high stocking densities is also a common issue that dairy calves experience during transportation and can reduce their ability to lie down and rest (Jongman and Butler, 2014). Bedding and flooring material can also affect the amount of time calves spend lying down during transportation and may contribute to calves experiencing more fatigue (Jongman
and Butler, 2014). Additionally, commingling of calves from different source farms can increase pathogen transmission and lead to greater disease challenges after arrival to calf-raisers (Taylor et al., 2010). These stressors associated with transportation may result in compromised health and welfare and contribute to higher morbidity and mortality rates after arrival to the calf-raising facility (Cave et al., 2005; Goetz et al., 2023a,b).

Current calf transportation research mainly describes physiological changes of young calves, and limited studies have investigated the effects of transportation on calf behavior (Goetz et al., 2022). One behavior that is likely affected by transportation is the amount of time calves can spend lying down. Typically, young calves spend the majority of their time lying down throughout the day. For example, 7.5-d-old calves housed in groups or individually spend an average of 16.9 h/d and 17.2 h/d lying down, respectively (Wormsbecher et al., 2017). However, during transportation, calves are exposed to multiple stressors, such as novel environments, commingling with new and unfamiliar animals, and braking and turning during driving (Trunkfield and Broom, 1990; reviewed by Creutzinger et al., 2021), all of which can potentially reduce lying time. Jongman and Butler (2014) found that, when given 0.5 m² of space during a 12-h journey, 3- to 10-d-old Holstein calves lay down for up to 70% of the trip. Jongman and Butler (2014) also found a relationship between calf age and lying time; 3-d-old Holstein calves spent more time lying down during 12 h of transportation and in the 12 h afterward compared with 5- and 10-d-old Holstein calves. Few studies have investigated the relationship between lying time and transportation for young dairy calves, and, to our knowledge, none have had the main objective of investigating the effect of varying durations of transportation on calf lying behavior. To understand the effects of transportation on calf welfare, further research is needed.

The main objective of this study was to determine the effect of different durations of transportation (6, 12, and 16 h) on lying time and lying bouts of young surplus dairy calves on the day of and days following transportation from dairy farms to a veal facility. A secondary objective of this study was to investigate whether calf age is associated with lying behavior around transportation. We hypothesized that calves transported for 16 h would lie down less and have more lying bouts on the day of transportation (d 0) than calves transported for 6 h, as more time spent in the trailer could increase fatigue. Additionally, trailer stops, starts, and turning may disrupt lying in calves, thereby increasing the number of lying bouts. Additionally, we hypothesized that younger calves would spend more time lying down and have fewer lying bouts in the days following transportation.

MATERIALS AND METHODS

Experimental Design

This project was part of a larger study investigating the effects of transportation duration on physiological and health outcomes of dairy calves (Goetz et al., 2023a,b). The University of Guelph Animal Care Committee approved animal use for this project (Animal Use Protocol no. 4430).

The sample size for this study was calculated based on physiological and health outcomes, rather than lying behavior (Goetz et al., 2023a,b); however, we anticipate that the sample size is larger than what would be required based on similar studies (Knowles et al., 1997; Fisher et al., 2014). A total of 175 male (n = 150) and female (n = 25) surplus calves were enrolled in the study. Both Holstein (n = 120) and dairy-beef cross calves (n = 55) were included in the study. Calves from 5 dairy farms in southern Ontario, within 50 km of the University of Guelph, were enrolled at birth over a 2-wk period leading up to the day of transportation. Between 24 to 48 h after birth, a blood sample was collected via jugular venipuncture to assess serum total protein to determine passive transfer of immunity. Blood was allowed to clot and then centrifuged for 15 min at 1,500 \( \times g \) at room temperature (20°C). Serum was separated and frozen at –20°C. Radial immunodiffusion was performed by the Saskatoon Colostrum Company (Saskatoon, SK, Canada) for additional parameters. Daily health exams were conducted from birth until transportation for navel health, fecal consistency, and presence of respiratory disease (explained in companion papers by Goetz et al., 2023a,b).

Seven cohorts of calves were transported from October 2020 to June 2021. Multiple drivers were responsible for the 16-h duration of transportation; however, the same cattle transportation company was responsible for driving the truck for all cohorts. For each cohort of calves, a random allocation sequence generated in Microsoft Excel (Microsoft Corp., Redmond, WA) was used to randomly assign calves to 1 of 3 treatments on the day of transportation: (1) 6 h (n = 60), (2) 12 h (n = 58), or (3) 16 h (n = 57) of continuous transportation by road. Calves were blocked by farm and assigned to the sequence from youngest to oldest. Researchers were not blinded to the treatment allocation; however, the veal producer responsible for feeding and disease management was blinded.
Calves in all treatments were loaded onto a single gooseneck trailer from each dairy farm between 0550 and 0845 h. The trailer was disinfected before transportation and deeply bedded with clean, chopped straw. The trailer was 20.9 m² (9.1 m long by 2.3 m wide) and had a maximum capacity of 40 calves. Calves were dropped off at the veal facility in cohorts from different farms based on the transportation duration that they were assigned. A consistent space allowance was maintained by moving a sliding wall within the trailer at each drop-off point. Each cohort began with 20 calves or less, and so the partition was moved to the middle of the trailer (10.47 m² interior trailer space). Space allowance throughout the study ranged from 0.52 m² to 0.91 m² per calf. At the veal facility, calves were housed individually in outdoor hutches. In the hour after unloading, calves were health checked, weighed, and blood sampled (explained in detail in a another paper: Goetz et al., 2023a,b). Additionally, calves transported for 12 h and 16 h were fed 2 L of milk replacer by researchers within the hour after unloading. Calves transported for 6 h were fed 2 L of milk replacer by the veal producer approximately 4 h after unloading.

Data Collection

Calf lying and standing behavior was recorded using HOBO data loggers (Hobo Pendant G Acceleration Data Logger, Onset Computer Corporation; validated by Ledgerwood et al., 2010). Researchers attached a HOBO data logger to each calf’s medial left or right hind leg using Vet Wrap (Co-Flex, Andover Coated Products Inc., Maplewood, MN) 2 d before transportation and removed the loggers 4 d after transportation. The data loggers recorded the g-forces of the y-axis at 1-min intervals from attachment to removal.

Data Summarization

Lying time (min/h) and lying bouts (no./h) during the first 24 h after loading, daily lying time (h/d), and number of lying bouts (no./d) were summarized for each calf using the cut point reported by Ledgerwood et al. (2010) and a modified SAS algorithm (UBC Animal Welfare Program, 2013). Hour relative to loading was set by the time calves were loaded onto the trailer; hour 1 began when each calf was loaded onto the trailer. The 24-h time after loading was unique to transportation and removal of the loggers 4 d after transportation. The data loggers recorded the g-forces of the y-axis at 1-min intervals from attachment to removal.

Statistical Analysis

Data were imported from Microsoft Excel into Stata 17 (StataCorp LP, College Station, TX) for statistical analyses. In each analysis, calf was the experimental unit. Univariable analyses were conducted between outcome variables and each predictor variable. From the time calves began to be unloaded from the trailer (during the unloading of the group transported for 6 h), the environment of calves was different (i.e., at the veal facility or on the trailer) depending on treatment. Environment was a confounding factor to hourly lying time and bouts; as such, differences in lying behavior between treatments could not be statistically analyzed. Thus, lying time and lying bouts in the first 24 h after loading were assessed visually for descriptive purposes using a line graph generated in Stata 17, imported from Microsoft Excel.

To determine the effects of transportation duration on lying behavior, outcome variables included daily lying time relative to transportation (d −1 to d 3), daily lying bouts relative to transportation (d −1 to d 3), and percentage of lying time during transportation. Predictor variables included transportation duration (6, 12, or 16 h), transportation cohort (1–7), dairy farm of birth, age on the day of transportation (2 to 19 d), sex (male or female), breed (dairy-beef or Holstein), weight before loading on the day of transportation (kg), serum total protein concentration (g/dL), presence or absence of diarrhea on each day relative to loading, presence or absence of respiratory disease before loading on each day relative to loading, and number of diseases present on each day relative to loading (no disease present, 1 disease present, or 2 diseases present; described in Goetz et al. 2023a,b). In each model, age was categorized into quartiles to assess the relationship between calf age and lying behavior. Predictor variables with $P < 0.2$ were included for assessment in the multivariable model. The assumption of independence was evaluated using Spearman Rank coefficients for each of the variables and determined to be fulfilled if values were less
Stepwise backward elimination was used to build the final models, where variables with $P < 0.05$ were included in the final models. Hypothesis-driven comparisons were performed; 12 and 16 h of transportation were compared with 6 h, which was set as the referent in all models. With respect to age at transport, calves transported at 6 to 10 d old, 11 to 13 d old, and 14 to 19 d old were compared with those transported at 2 to 5 d old, which was set as the referent.

A repeated measures mixed linear regression model was created to identify factors associated with daily lying time (h/d). In the final model, transportation cohort, dairy farm of birth, transportation duration, age, and the interaction between day relative to transportation (d −1 to d 3) were included as fixed effects; calf was included as a random effect, and day relative to transportation was included a repeated measure (d −1 to d 3). Another repeated measures mixed linear regression model was created to assess daily lying bouts (no./d). In the final model, day relative to transportation (d −1 to d 3) was included as the repeated measure; transportation cohort, dairy farm of birth, transportation duration, breed, age, presence or absence of respiratory disease, and interaction between day relative to transportation and transportation duration were included as fixed effects, with calf included as a random effect.

Finally, a mixed linear regression model was created to investigate the percentage of time that calves spent lying during transportation. In the final model, farm, transportation duration, and age were included as fixed effects, with transportation cohort being included as a random effect. Normality of residuals was evaluated for each of the models visually, using residual plots. Statistical significance was declared at $P < 0.05$. To account for type I error, a Bonferroni adjustment was made for each repeated measures model.

RESULTS

Descriptive Results

A total of 167 calves (6 h = 55, 12 h = 58, 16 h = 54) were included in the lying behavior analysis before, during, and after transportation. The median age of calves at loading was 11 d (range 2 to 19 d) with 47 calves (27%) transported at less than 1 wk old. In all, 27% of calves were 2 to 5 d old, 32.2% of calves were 6 to 10 d old, 17.5% of calves were 11 to 13 d old, and...
23.3% of calves were 14 to 19 d old. Calf sex \( (P = 0.71) \), breed \( (P = 0.87) \), and age \( (P = 0.79) \) were not statistically different across treatment groups.

**Hourly Lying Behavior**

Immediately after loading, hourly lying time for all treatment groups seemed to increase steadily (Figure 1). In the hour after unloading for the 6-h treatment (6 to 7 h), lying time slightly decreased before sharply increasing from h 7 to 8 and then decreasing again. In the hour after unloading for the 12-h treatment (12 to 13 h) and for the 16-h treatment (16 to 17 h), lying time decreased before beginning to increase again at the next hour. During transportation, lying bouts for all treatment groups ranged between 1 to 2 bouts per hour (Figure 2). Calves transported for 6 h and 12 h showed a sharp decline in the number of lying bouts after unloading. The number of lying bouts for calves transported for 16 h stayed consistent until a decline approximately 1 h after unloading. Around feeding (10 h for the 6-h treatment; 13 h for the 12-h treatment; 17 h for the 16-h treatment), the calves transported for 6 h showed an increase in lying bouts, whereas lying bouts for the calves transported for 12 h and 16 h continuously decreased.

**Daily Lying Time**

We found an interaction between treatment and day relative to transportation for daily lying time \( (P < 0.01) \). On the day of transportation (d 0), calves transported for 16 h spent 2.0 h less lying down than did calves transported for 6 h \( (P < 0.01, \text{ 95\% CI: } -2.8 \text{ to } -1.3; \text{ Figure 3}) \) and calves transported for 12 h spent 1.2 h less lying down than calves transported for 6 h \( (P < 0.01, \text{ 95\% CI: } -2.0 \text{ to } -0.4) \). On the day after transportation (d 1), calves transported for 16 h spent 1.1 h more lying than calves that were transported for 6 h \( (P < 0.01, \text{ 95\% CI: } -0.3 \text{ to } 1.8) \). Daily lying time was not different between treatments on d 2 and d 3 after transportation.

**Daily Lying Bouts**

We detected an interaction between treatment and day relative to transportation on daily lying bouts \( (P < 0.01) \). On the day of transportation (d 0), calves that
were transported for 16 h had 7.9 more lying bouts than calves transported for 6 h ($P < 0.01$, 95% CI: 5.5 to 10.4), and calves transported for 12 h had 3.8 more lying bouts than calves transported for 6 h ($P < 0.01$, 95% CI: 1.4 to 6.2; Figure 4). On the day before transportation (d −1) and on the days after transportation (d 1–3), daily lying bouts were not affected by treatment.

**Percentage of Lying Time During Transportation**

Percentage of time spent lying down (%) during transportation was positively associated with transportation duration ($P < 0.01$). Calves transported for 16 h spent a greater percentage of time lying than did calves transported for 6 h ($\Delta = +7.6\%$; $P < 0.01$, 95% CI: 3.7 to 11.4%). Calves transported for 12 h also spent a greater percentage of time lying down than calves transported for 6 h ($\Delta = +5.8\%$; $P < 0.01$, 95% CI: 1.9 to 9.7%; Figure 5).

**Calf Age and Daily Lying Time**

We found an interaction between calf age and day relative to transportation on daily lying time ($P < 0.001$). On the day before transportation (d −1), 2- to 5-d-old calves spent 1.2 h more lying down than 6- to 10-d-old calves ($P < 0.01$, 95% CI: −2.1 to −0.3; Figure 6), 1.2 h more lying down than 11- to 13-d-old calves ($P = 0.01$, 95% CI: −1.9 to −0.2), and 2.1 h more lying down than 14- to 19-d-old calves ($P < 0.01$, 95% CI: −3.1 to −1.1). On the day of transportation (d 0), 2- to 5-d-old calves spent 1.6 h more lying down than did 6- to 10-d-old calves ($P < 0.01$, 95% CI: −2.5 to −0.8), 2.2 h more lying down than 11- to 13-d-old calves ($P < 0.01$, 95% CI: −3.8 to −1.9). On the day after transportation (d 1), 2- to 5-d-old calves spent 0.9 h more lying down than calves 6 to 10 d old ($P < 0.01$, 95% CI: −1.4 to −0.3), 1.4 h more lying down than 11- to 13-d-old calves ($P < 0.01$, 95% CI: −2.1 to −0.7) and 1.8 h more lying down than 14- to 19-d-old calves ($P < 0.01$, 95% CI: −3.2 to −1.2). Two days after transportation (d 2), 2- to 5-d-old calves spent 1.1 h more lying down than 6- to 10-d-old calves ($P < 0.01$, 95% CI: −2.0 to −0.2), 1.9 h more lying down than 11- to 13-d-old calves ($P < 0.01$, 95% CI: −2.9 to −0.8), and 2.2 h more lying down than 14- to 19-d-old calves ($P < 0.01$, 95% CI:
Three days after transportation (d 3), 2- to 5-d-old calves spent 1.4 h more lying down than 6- to 10-d-old calves ($P < 0.01$, 95% CI: −2.3 to −0.5), 1.8 h more lying down than 11- to 13-d-old calves ($P < 0.01$, 95% CI: −2.9 to −0.8), and 1.9 h more lying down than 14- to 19-d-old calves ($P < 0.01$, 95% CI: −2.9 to −1.0).

**Calf Age and Daily Lying Bouts**

Age had a significant relationship with the number of daily lying bouts ($P = 0.01$). Overall, calves aged 2 to 5 d had more daily lying bouts than did 11- to 13-d-old calves ($\Delta = +2.5$; $P = 0.02$, 95% CI: −4.7 to −0.38) and 14- to 19-d-old calves ($\Delta = +2.2$; $P = 0.04$, 95% CI: −4.2 to −0.2).

**Calf Age and Percentage of Time Lying Down During Transportation**

Calf age was associated with the percentage of time spent lying down during transportation ($P < 0.01$). Specifically, 2- to 5-d-old calves spent more time lying down during transportation than did 6- to 10-d-old calves ($\Delta = +10.1$%; $P < 0.01$, 95% CI: −14.3 to −5.9), 11- to 13-d-old calves ($\Delta = +16.4$%; $P < 0.01$, 95% CI: −21.5 to −11.4), and 14- to 19-d-old calves ($\Delta = +18.9$%; $P < 0.01$, 95% CI: −23.6 to −14.3).

**DISCUSSION**

The aim of this study was to investigate the effects of different durations of transportation (6, 12, or 16 h) on lying time and lying bouts of young surplus dairy calves in the days surrounding transportation from dairy farms to a veal facility. A secondary objective of this study was to investigate whether calf age was associated with lying behavior around transportation.

In this study, we found that calves transported for 12 h and 16 h had more lying bouts on the day of transportation (d 0) than did calves transported for 6 h. On the day of transportation, calves transported for 16 h had 30 lying bouts, whereas calves transported for 12 h and for 6 h had 26 and 22 lying bouts, respectively. Comparatively, Wormsbecher et al. (2017) found that 7.5-d-old pair-housed Holstein calves had an average
of 23.5 lying bouts per day. A greater number of lying bouts may suggest that longer durations (i.e., 12 h, 16 h) of transportation may be more disruptive to calves compared with short durations (6 h).

Lying time on the day after transportation was affected by transportation duration. Calves transported for 16 h spent more time lying on the day after transportation (d 1) than calves transported for 6 h. Another transportation study found that 7-mo-old beef calves transported for 36 h with 8-h rest periods spent more time lying on the day after transportation than did calves transported for 12 h with 8-h rest periods (Meléndez et al., 2020). Increased lying time in calves transported for longer durations may suggest that calves are more fatigued from longer transportation time and cope by lying for greater amounts after transportation. Calves transported for 12 and 16 h spent 5.8% and 7.6% more time lying on the trailer than those transported for 6 h, respectively. Marcato et al. (2020) investigated the relationship between transportation duration and percentage of time spent lying down during transportation; they found that Holstein Friesian calves spent an average of 61% of the journey lying, with no differences between calves transported for 6 h or 18 h. Additionally, consistent with the higher activity of calves that were transported for 6 h compared with calves that were transported for 16 h, greater negative energy balance occurred in calves transported for longer durations (i.e., 12 h and 16 vs. 6 h; explained in Goetz et al., 2023a,b). Investigating calf lying behavior during transportation provides insight into calves’ abilities to cope with long durations of transportation.

Age at the time of transport was also associated with daily lying time. Older calves spent less time lying on the day before transportation and in the days following transportation (d –1 to d 3) compared with younger calves. Similarly, Jongman and Butler (2014) found that 3-d-old Friesian and Friesian-cross calves spent more time lying immediately after arrival and during the 12 h after arrival to a veal farm than did 5- and 10-d-old calves. The results of this study indicate that lying time is associated with age and that younger calves show a greater need for rest, which may be exacerbated by transportation, compared with older calves. Differences in lying time are important to consider because calves are typically transported to veal and calf-raisers from dairy farms at 3 to 7 d of age (Wilson et al., 2020), and our results suggest that calves of different ages perform different lying behaviors around transportation. Further research is needed to determine the implications of age for calf welfare, as by assessing behavioral outcomes such as vocalizations during transportation.

Calf age was also associated with the percentage of lying time during transportation. Older calves spent less time lying down during transportation than younger calves (2 to 5 d vs. 14 to 19 d: 63.5% vs. 45.4%, respectively). Our results are similar to those reported by Jongman and Butler (2014), who found that 3-d-old calves spent 59% of time lying during transportation compared with 5-d-old and 10-d-old calves, who spent 48% and 42% of time lying during 12 h of transportation, respectively. Elevated lying time for calves transported at younger ages indicates that young calves are likely more fatigued by transportation than older calves are. Thus, older calves may be better suited for longer journeys compared with younger calves.

Regardless of age, surplus calves should ideally be transported in clean, dry, and deeply bedded trailers, with adequate space allowance for calves to lie down comfortably. Providing calves with a clean, dry, and deeply bedded environment with straw in the winter and sawdust in the summer increases calf comfort (Kimeli et al., 2021), aids in coping with varying temperatures (Camiloti et al., 2012), and decreases pathogen transmission (McGuirk, 2008). Additionally, a space allowance of more than 0.3 m² per calf increases time spent lying down during transportation (Todd et al., 2000) and decreases muscle damage (Jongman and Butler, 2014).

Exposure to a novel social environment may have affected lying behavior and is a limitation in this study. Introduction to group housing from individual housing...
has been shown to cause an increase in the frequency of lying bouts in 60-d-old dairy calves (Horvath and Miller-Cushon, 2018). Calves were individually housed before and after transportation but were commingled with unfamiliar calves in the trailer and experienced social interactions with other calves for the first time at the time of loading onto the trailer. Additionally, when introduced to a novel environment, De Paula Vieira and colleagues (2012) found that 65- to 69-d-old individually housed Holstein calves spent more time being active and running in the new environment than did group-housed Holstein calves. Lying behavior on the day of transportation in this study may have been affected by the exposure to 2 novel environments on the day of transportation, including the transportation trailer and the veal facility, and the first time experiencing social interactions with conspecifics.

**CONCLUSIONS**

Longer durations of transportation were positively associated with lying behavior of 2- to 19-d-old surplus calves both during and on the days following transportation. Calves transported for longer durations (12 or 16 h) spent less time lying down and had a greater number of lying bouts on the day of transportation (d 0) than did calves transported for shorter durations (6 h). These results suggest that lying behavior is continuously disturbed during transportation. Calves transported for 16 h had the greatest lying time on the day following transportation (d 1) compared with calves transported for 6 or 12 h, indicating that longer trip durations cause calves to become more fatigued and show a greater need for rest. Finally, calves transported at younger ages had greater lying time on each day relative to transportation (d −1 to 3) than older calves, suggesting that younger calves may become fatigued more easily and show an increased need for rest, which could be exacerbated by transportation. Future studies should also investigate behavioral signs of distress and discomfort around transportation, such as vocalizations, to assess the animal welfare implications of long-distance transportation for young calves.
ACKNOWLEDGMENTS

The first author was supported by Dairy Farmers of Canada (Ottawa, Ontario, Canada). The authors have not stated any conflicts of interest.

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