Does transportation of young dairy calves impact their health and welfare?

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Abstract
The transportation of young dairy calves has come under increased scrutiny due to new legislation in several countries and research highlighting the challenges associated with this practice. Studies have consistently shown that transportation, especially long distance transportation, can lead to higher levels of disease and negatively impact calf welfare. To overcome challenges associated with transportation, it is critical to consider the following strategies: 1) reduce the duration of transport; 2) transport calves at an older age; 3) offer a milk meal before or during transit; and 4) ensure calves are fit for transport. Implementing these practices could help reduce the impact of transport and improve the health and well-being of young dairy calves.

Key words:non-replacement, calf welfare, legislation, transit

Introduction
Nearly all non-replacement dairy calves, defined as calves not needed for milk production (i.e., male Holstein calves and cross-bred calves), are transported from their source dairy farm to another location to be raised. In Canada and the United States, it is estimated that more than 5.2 million non-replacement calves were produced by the dairy industry in 2020, whereas in the European Union, including the United Kingdom, about 11 million calves were produced[1]. Furthermore, female calves retained to produce milk can alsobe raised off-site, with 1 in 10 operations in the United States raising some of their dairy heifers off-site[2]. Cumulatively, it is clear that a substantial number of calves are transported on an annual basis; however, despite its commonality, limited research has evaluated the impact of this practice. The objective of this narrative review is to highlight the impacts of transportation of young dairy calves and to evaluate mechanisms to overcome challenges posed by transportation.

Impact of transportation
Transportation poses a significant stress for young dairy calvesbecause of commingling with animals from different sources, deprivation of feed and water, and exposure to fluctuating temperatures[3]. Time in transit is one of the most studiedfactors related to transport[4], with several recent studies exploring its impact. Goetz et al. randomly allocated 175 dairy calves, with a median age of 11 days at transport, to be transported for either 6, 12, or 16 continuous hours[4]. The study found that calves transport for 16 hours had increased odds of prolonged skin tent, and a higher incidence of diarrhea compared to those transported for 6 hours. Furthermore, in the youngest group of calves (aged 2 to 6 days) transported for 16 hours, there was a higher incidence of respiratory disease compared to older calves transported for the same duration. In the12-hourtransport group, calves also had an elevated odds of a prolonged skin tent compared to the 6 hour group.Building on these findings, a New Zealand study with 194 calves found that the risk of mortality increased by 1.45 times for every additional hour of travel[5].Another study comparing calves transported for 3 to 5 hours to those transported for more than 24 hours found that longer transport duration (24 hours)was associated with a higher incidence of respiratory disease (67% vs. 41%)[6]. Although the exact mechanisms driving the differences in health is not fully understood, there are likely a combination of factors. Chronic stress has been shown to suppress the immune system of cattle and increase susceptibility to disease, particularly in young animals that lack the ability to thermoregulate and maintain homeostatis[7]. Furthermore, time away from feed leads to increased levels of non-esterified fatty acids and lower levels of glucose during long-distance transport, furtherimpairing immune function[8].

Calvesalso alter their behaviour due to transportation. Specifically, calves transported long distances spend less time lying down and have more lying bouts on the day of transport compared to shorter distances[9]. This suggeststhat long-distance transport is more disruptive to calves compared to short trips. As a result, calves are more fatigued on the day following transport and have a higher lying time compared to calves transported for a shorter period.

Solutions to mitigate the impact of transport

To combat challenges associated with transportation, there are several considerations. The first, and likely most important, is to reduce the time that calves spend in transit. As outlined above, if the time in transit can be minimized, it is associated with improved health and welfare. Due to this reason, legislation surrounding transportation is mainly focused on time in transit, with a maximum allowable time in transit being 12 hours in Canada and New Zealand, 8 hours for calves < 14 days of age and 19 hours for calves > 14 days of age in the European Union, 6 hours for calves < 5 days of age and 12 hours for calves aged 5 to 30 days of age in Australia, and 28 hours in the United States. Other considerations include (1) Age at transit; (2) Providing a rest period; (3) Nutrition prior to or during transit; and (4) fitness for transport.

Age at transit

The age at which calves depart the dairy farm of origin is a critical factor that influences success at the calf raiser. A Dutch study, which included 683 calves, randomly assigned calves to be transported at 14 and 28 days of age. They found that mortality risk (2.8% vs. 5.9%) and prevalence of being treated with medicines other than antimicrobials (21.7% vs. 27.1%) was lower in calves transported at 28 days of age[10]. Furthermore, the carcass weight was also higher (+ 14.8 kg) in calves transported at 28 days of age. Another study of 170 calves, with ages ranging from 6 to 24 days of age at transport, found that calves transported at 10 days of age or older had a reduced odds of respiratory disease and calves 13 to 24 days of age had a lower odds of being dehydrated at arrival and having diarrhea compared to calves aged 6 to 8 days old at transportation[11]. An observation study also had similar findings where calves transported over 21 days of age had lower levels of mortality and disease compared to calves that were less than 1 week at transportation[12]. Altogether, these studies, and others, highlight that older calves may be more robust and have greater success once they reach the calf raiser. This may be the reason that some countries have put into place minimum ages at which calves can leave the source dairy farm, including a minimum of 9 and 6 days of age for calves destined for auctions or collection centers in Canada and Australia, respectively, and 14 days of age and 4 days of age for all calves leaving the dairy farm in the European Union and New Zealand, respectively.

Providing a rest period

A possible mitigation strategy to address long distance transportation is providing a rest period, although the effects of this practice are not well understood. A recent study was conducted where calves were randomly assigned to either be transported for 16 continuous hours or be transported for 8 hours, have an 8 hour rest-period with 2 feedings of milk, then further transported for 8 hours[11]. Overall, few differences were found, with calves receiving a rest period having lower levels of non-esterified fatty acids immediately after transport and higher levels of growth in calves transported at 9 to 10 days old. However, it was also found that calves in the rest period group spent more time lying on the day following transport compared to continuously transported calves, suggesting they may have been more fatigued. Another study fed calves an electrolyte at eight-hour intervals during a 24 hour period of transportation, but minor benefits were found which, in the authors opinion, did not justify the disruption caused by loading and unloading calves[13]. A follow-up study by the same group of authors enrolled 120 calves that were assigned to be transported for 19 hours including a one-hour rest stop where they were fed nothing, water, or electrolytes, also found minimal benefit to a mid-journey feeding[14]. Overall, it is unclear whether a rest period improves the ability of calves to withstand transportation. Existing studies suggest that the benefits are minimal.

Nutrition prior to and during transport

Given that calves undergo long periods of fasting during transport, it is important to consider the role that nutrition plays. Marcota et al. transported 368 calves in a 2 x 2 x 2 factorial design evaluating transport duration, type of trailer, and nutrition. Specifically, with respect to nutrition, calves received either 1.5 L of milk replacer or electrolytes prior to transportation. In calves that received milk prior to a 6 hour journey, they had higher levels of glucose, and lower levels of non-esterified fatty acids compared to calves fed electrolytes. Furthermore, electrolyte-fed calves lost body weight during the 6 hours of transport, whereas calves fed milk gained body weight. Interestingly, no differences were found between calves fed milk compared to electrolytes in those transported for

18 hours[15]. Another study randomly allocated 128 calves to receive milk replacer or one of two electrolyte solutions during a rest period. It was found that calves fed the electrolytes had higher concentrations of non-esterified fatty acids and beta hydroxybutyric acidcompared to calves fed milk replacer[16]. Furthermore, there was a tendency for calves fed electrolytes to have a higher level of diarrhea and respiratory disease compared to calves fed milk replacer during the rest period. Overall, this body of literature suggests that providing a meal of milk replacer, either immediately prior to transportation or during a rest period, could improve energy status and health after arrival to a calf raiser.

Fitness for transport

At arrival to calf raisers, it is commonly noted that calves are in suboptimal condition. For example, a study evaluating 383 calves arrivingat 6 commercial veal farms in Ohio found that 14% had diarrhea, 0.5% had respiratory disease, 14% had a depressed attitude, 27% had an inflamed umbilicus, and 35% were dehydrated[17]. Similarly, a Canadian study that assessed 998 calves assessed at arrival to a veal facility found that 32% were clinically dehydrated, 20% had an inflamed umbilicus, 14% had diarrhea, and 8% were dull or depressed[18]. Whiletransportation can affect calves' health status at arrival,the condition of calves at the farm of origin prior to transport also significantly influences this. Wilson et al. demonstrated this by examining 640 calves at 17 dairy farms in British Colombia prior to their transport to two calf raising facilities[19]. Overall, it was found that calves that had an umbilical infection at the source dairy farm were 2.8 times more likely to be treated for diarrhea at the calf raiser, whereas calves that were dull or depressed were 2.5 times more likely to die. Additionally, calves with higher body weights before transportation had a lower odds of being treated for diarrhea. In fact, body weight at arrival to calf raising facilities has been demonstrated to be the most important influencer of future mortality and morbidity risk as well as growth. Lower levels of disease and mortality, especially in the first 21 days after arrival, in calves that were heavier at arrival has been found in a plethora of studies[20]. This association likely reflects the age of calves at the time of transportation but also the nutrition provided to calves prior to transport[21]. Fitness for transport could also include an assessment of transfer of passive immunity status as higher levels of immunoglobulin G at arrival to calf raisers has been associated with lower levels of mortality and morbidity and higher levels of average daily gain[22]. Hence, calf transporters and dairy farmers shouldensure calves have no abnormal clinical signs of disease (i.e., fever, cough, tachypnea/dyspnea, nasal or ocular discharge, diarrhea, lameness, or dehydration), a body weight of > 50 kg (> 110 lbs) for Holstein calves(ideal body weight for crossbred calves is unknown), and a serum IgG of > 10 g/L to ensure calves are fit for transport. Although assessing passive immunity on individual calves may not be practical, it could be periodically assessed to evaluate the herd-level passive immunity and benchmarked to motivate improvement among peers[23].

Summary

Transport, especially for long distances, have been shown to increase disease and alter the behaviour of calves during and after the journey. Reducing transit time is crucial for improving calf health and welfare, with the age of the calves at the time of transport also being a significant factor. Several studies have found older calves have greater success following arrival to the calf raiser. Providing a milk meal prior to or during transport improves the calves' energy levels and health of calves at arrival to calf raisers. At the dairy farm of origin, prior to putting the calf onto the trailer, the calf should be examined for signs of disease, body weight, and, when possible, passive immunity status to ensure they are fit for transport. Although, few studies have evaluated the impact of a rest period, there seems to be minimal benefit, and it is likely better to get the calves to their final destination without the stress of loading and unloading multiple times.

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