THESIS

PREWEANED CALF TRANSPORTATION PRACTICES IN THE UNITED STATES: A SURVEY OF DAIRIES, CALF RAISERS, AND HAULERS

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ABSTRACT

PREWEANED CALF TRANSPORTATION PRACTICES IN THE UNITED STATES: A SURVEY OF DAIRIES, CALF RAISERS, AND HAULERS

Transport is recognized as a welfare concern for livestock, but young calves are especially vulnerable to transport challenges. Despite this knowledge, little research is available describing transportation practices of preweaned dairy calves in the United States. Therefore, the objectives of this study were to (1) describe the current industry practices regarding the transportation of preweaned dairy and beef-on-dairy crossbred calves, (2) determine differences in pre-transport management on dairies between replacement heifers, beef-on-dairy crossbreds, and dairy bull calves, and (3) identify outreach and research needs to address calf welfare concerns related to transportation. Individuals who make decisions about transporting and receiving preweaned dairy or beef-on-dairy calves within the United States were recruited through digital advertisement, email, and extension agents to complete an online survey in 2023. A total of 123 responses were accepted for analysis and consisted of 69 dairy operations that sold or shipped preweaned calves, 29 operations that received preweaned calves, and 25 hauling companies that transported preweaned calves in 2022. The survey used a branching method to direct respondents to complete one of four surveys, each containing different questions based on their selected role: 1) dairies that sell or contract out calf raising for preweaned calves, 2) dairies that transport and raise preweaned calves at another location, 3) operations that receive preweaned calves after transport (e.g., auctions, livestock markets, calf ranches, etc.), and 4) haulers that transport preweaned calves. Question topics for dairy operations included pre-transport practices such as colostrum management, health evaluations, and marketing practices. Questions for operations that received calves included calf condition upon arrival, disease incidence during the preweaning period, and preconditioning requirements. Questions for hauling companies included distances traveled, number of operations, and calves' final destination. Bhapkar, Kruskal-Wallis, or McNemar tests were conducted to determine differences in management practices at

the dairy prior to transport. The predictor of interest was calf class: replacement heifer, beef-on-dairy, and dairy bull. Outcomes of interest included: age at transport, timing after birth to first colostrum feeding, total colostrum quantity, milk feeding prior to transport, access to water immediately prior to transport, median distance, and median duration.

Out of the 69 dairy operations accepted for analysis, 40 dairy operations transported 284,597 replacement heifers, 58 dairy operations transported 263,104 beef-on-dairy crosses, and 57 dairy operations transported 33,146 dairy bull calves prior to weaning. The age at transport for the majority of calves differed between calf class ($P < 0.009$). A difference in timing to first colostrum feeding was seen between replacement heifer and beef-on-dairy calves ($P = 0.02$). A difference in timing to first colostrum feeding was seen between replacement heifer and dairy bull calves as well ($P = 0.02$). Some preconditioning practices differed between replacement heifer and beef-on-dairy calves and between beef-on-dairy and dairy bull calves ($P < 0.05$). Operations that received preweaned calves reported wide variabilities in the prevalences of morbidity and mortality in calves following transport, suggesting a lack of uniformity in calf care across the industry. While the study was limited by a small sample size, our findings provide a deeper understanding of transport management practices in the United States that can help guide future research and outreach efforts to promote the health and welfare of dairy calves and support the longevity of the dairy industry.

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DEDICATION

To my parents, whose sacrifices I will never truly fathom, you have provided me with the opportunities and possibilities that have brought me to where I am today.

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CHAPTER 1: LITERATURE REVIEW

1.1 Introduction

In 2023, U.S. dairy operations were estimated to produce a total calf crop of 9.3 million head (USDA, 2024). Approximately 5 million of these calves were transported off the dairy at a young age, often before weaning (USDA, 2024; USDA, 2016; Norman et al., 2010). Transport poses significant welfare concerns for all livestock, exposing them to stressors such as improper handling, commingling with unfamiliar animals, prolonged periods without feed or water, and fluctuating environmental conditions (Grandin, 2001; Trunkfield and Broom, 1990). Preweaned calves are particularly vulnerable to transport stressors due to their reliance on milk or milk replacers as their primary source of nutrition, as they have not yet transitioned to a grain-based diet (National Academies of Sciences, Engineering, and Medicine, 2021). Additionally, these calves are still developing critical physiological functions, including immature immune systems, an underdeveloped hypothalamic-pituitary axis, and limited thermoregulation abilities, which can exacerbate the stressors of transport (Godden et al., 2019; Eicher, 2001; Bernardini et al., 2012).

Specifically in young calves, transportation has been associated with morbidity, mortality, and poor performance (Kent and Ewbank, 1986; Rot et al., 2022; Goetz et al., 2023b; Marcato et al., 2022b; Masmeijer et al., 2019). Kent and Ewbank (1986) found that calves subjected to fasting and transport lost substantially more body weight than fasted calves that were not transported. Masmeijer et al. (2019) found that underweight calves were more susceptible to disease when transported compared to those kept in the operation. Additionally, reduced growth

rates and lower carcass weights have been reported in calves transported at younger ages (Rot et al., 2022; Goetz et al., 2023b; Marcato et al., 2022b). High morbidity rates have been reported post-transport, specifically for diarrhea, respiratory disease, and navel inflammation (England et al., 2023; Maggard et al., 2023). Previously reported mortality rates for young calves during and immediately after transport range from 0.6% to 0.7% (Cave et al., 2005; Thomas and Jordaan, 2013), and in more recent years, mortality rates up to 7% have been reported during the 2-to-4-week post-transport period (Pempek et al., 2017; Urie et al., 2018; Scott et al., 2019).

Transportation poses substantial welfare challenges for calves (Cramer et al., 2024b) and current practices in calf care and marketing in the United States often fail to meet public expectations for animal welfare, drawing scrutiny from consumers and stakeholders (Weary and von Keyserlingk, 2017). Over the years, public concerns surrounding calf care and transport have increased, emphasizing the need for practices that align with societal values and ensure the dairy industry's sustainability (Weary and von Keyserlingk, 2017; Beaver et al., 2020). Improving calf welfare during and after transportation requires effective management practices. However, significant gaps remain in our understanding of the best preparation methods, including optimal nutrition, supplementation strategies, and appropriate transport age (Roadknight et al., 2021a; Cramer et al., 2024b; Goetz et al., 2022). A comprehensive understanding of practices across various sectors is crucial to identify these gaps and establish evidence-based recommendations. Therefore, the purpose of this literature review is (1) to summarize the existing research regarding dairy calf transportation practices, challenges, and impacts of transportation on calf health and welfare, and (2) to identify gaps in the literature and highlight areas for future research.

1.2 Current Calf Transportation Practices in the United States

Transport regulations

In the United States, preweaned calves fall under the same transportation legislation established for all food production animals, which states that livestock may be confined in transport for up to 28 consecutive hours before they must unload for food, water, and rest (United States Code, 1994). The minimum age of calves at transport is not legislated in the United States. Countries such as Canada, Australia, New Zealand, and those within the European Union have addressed calf transport through specific legislation, as summarized in Table 1. For example, Canadian legislation states that calves aged eight days or less may be transported up to 12 hours, and calves may be withheld food and water for up to 12 hours (Government of Canada, 2023). Additionally, Canada requires that calves less than nine days old only be transported once and not through auctions or assembly centers. The maximum transport time in Australia and New Zealand is 12 hours for calves at least four and five days old, respectively (Animal Health Australia, 2012; New Zealand Government, 2018). Additionally, in Australia, calves less than six days old may be transported for up to six hours but not to sale barns or abattoirs (Animal Health Australia, 2012). The European Union limits transport to nine hours before requiring a one-hour break. In the European Union, the minimum age for transport is 14 days if traveling more than eight hours, and calves less than 10 days old may travel up to 100 km (Council of the European Union, 2004). Calves in the European Union may be withheld from feed for up to 19 hours (Council of the European Union, 2004). While these regulations are designed to minimize the impact of transport on young calves, there is a lack of scientific evidence to demonstrate their effectiveness, which means that health and welfare may still be compromised under such

conditions (Jongman and Butler, 2014; Roadknight et al., 2021a). The United States can adopt a more proactive approach to calf transport management by identifying and implementing scientifically supported best practices that mitigate health and welfare challenges. To achieve this, it is essential to address the significant knowledge gap in current calf transport practices in the United States. Documentation and analysis of current practices is the first step toward understanding the effects of calf transportation and identifying areas for improvement. This approach will enable the evaluation of how transportation practices specific to the United States influence calf health, welfare, and performance, which can help validate regulations and inform the development of additional measures to mitigate negative outcomes effectively.

Transport practices for replacement heifer calves

Each year, a portion of the female calves born on United States dairies are kept as replacement heifers. Dairy operations typically retain female calves as replacement heifers to replace 25% to 30% of their existing herd every year (Heinrichs and Swartz, 1991). In 2023, over 4 million calves were estimated to be kept as replacement heifers for the United States milking herd (USDA, 2024).

Over the years, an increasing number of dairy operations have opted to raise their replacement heifer calves off-site (Wolf, 2003). For example, the proportion of operations that reported raising heifer calves off-site with retained ownership has steadily increased from less than 4% of operations in 2002 to approximately 12% of operations in 2014 (USDA, 2002; USDA, 2016). In the same 12 years, the percentage of dairy heifer calves born on-site but raised off-site with retained ownership increased from 7% to over a quarter of all heifers (25.7%; USDA, 2002; USDA, 2016). Currently, it is estimated that 35% of dairy operations either sell or raise heifer calves off-site, and 43% of dairy heifer calves are either sold or raised off-site with

retained ownership (USDA, 2016). Although an exact number of transported replacement heifers is not available, we estimate that millions are transported annually in the United States.

There are two primary reasons why operations may choose to raise their replacement heifers off-site. Calf raising is reported as the second or third most costly expense for most dairy operations, accounting for about 20% of total operation costs (USDA, 2010; USDA, 2021; Heinrichs,1993). In addition, larger operations more frequently report raising their calves off-site (Heinrichs 1993, Wolf 2003). Almost a third of large operations (500+ herd size) report raising their preweaned calves off-site compared with 7.1% of medium operations (100-499) and 1.7% of small operations (<100; USDA, 2007; USDA, 2010). As dairy operations expand and seek cost-effective management strategies, more replacement heifer calves are being transported to off-site rearing facilities, increasing the number of young calves undergoing transportation (Heinrichs 1993, Wolf 2003). For operations that report transporting any heifers off-site, about half indicated primarily transporting preweaned calves (USDA, 2010; USDA, 2021). The average age of calves at the time of transport is reported as less than seven days of age (USDA, 2007; USDA, 2012; USDA, 2016; USDA, 2021). The average age at arrival at calf-raising facilities was three days old (USDA, 2012; USDA, 2016).

On average, most operations (84.6%) that sent heifers offsite to be reared report transporting calves 50 miles or less but over 20% of operations reported transporting preweaned calves greater than 100 miles (USDA, 2012). A United States study estimated that calves aged 7–10 days were transported between 450 km (280 miles) and 977 km (607 miles) from livestock auctions in the Northeast to calf-raising facilities in Ohio (Pempek et al., 2017). Additionally, about one in three (34.1%) heifer-raising operations reported receiving shipments that crossed state borders (USDA, 2012).

Transport practices for non-replacement calves

The remaining calves born on dairies that are not selected for the replacement herd will likely enter the beef supply chain (USDA, 2013; Fanatico, 2010). These calves are referred to as "non-replacement calves" or "surplus calves." Non-replacement calves include male dairy calves, beef-on-dairy calves (male or female), and potentially a small proportion of heifer calves deemed unsuitable as future dairy animals (De Vries et al., 2008). Most (68%) non-replacement male calves are sold and shipped off the dairy to enter veal or beef supply chains (Pempek et al., 2024). About 90% of all operations sell or raise dairy bull and steer calves off-site, which translated to 88% of all dairy bull and steer calves (USDA, 2016).

Since the dairy industry primarily profits from milk production, non-replacement calves have historically been viewed as low-value by-products. As a result, these calves may have received suboptimal care compared to replacement heifers, which makes them more susceptible to poor health and performance outcomes (Cave et al., 2005; Renaud et al., 2018). However, due to a decrease in beef calf inventories, combined with increased use of sexed semen on dairies, the economic interest for non-replacement calves of dairy origin in the US has recently increased (USDA, 2024; De Vries et al., 2008; Ahola J., personal communication, Colorado State University, 2024). To provide greater economic value to non-replacement dairy calves and meet the demand for beef supply, producers inseminate dairy cows with beef semen, resulting in beef-on-dairy crosses that generate higher revenue in the beef supply chain (Berry, 2021). As a result, the proportion of dairies using beef semen in their dairy cows has increased substantially in recent years to over 80% of operations in top milk-producing states (Pereira et al., 2022; Felix et al., 2023). As breeding beef-on-dairy becomes more prevalent, it is likely contributing to an

increase in the number of calves being transported off the dairy at a young age to specialized calf-raising operations.

Roughly 40% of male calves born in the United States are sold through auctions, with the remainder sold directly to a calf raiser (30%) or dealer (18%; Creutzinger et al., 2021; USDA, 2016). Differences in management practices between male and female calves have been documented in previous studies, such as male dairy calves were more likely to receive lesser quantities of colostrum, experience delayed feedings, and receive poor-quality or contaminated colostrum compared to female calves (Renaud et al., 2017; Renaud et al., 2020; Shivley et al., 2019). While there are national reports detailing practices for heifer calves within the industry, similar comprehensive reports for male dairy calves are limited. A preliminary study by Cramer et al. (2024a) was one of the first observational studies to explore the effects of transportation management on preweaned beef-on-dairy and Holstein bull calves. By collecting data before, during, and after transport, the study was able to describe the health status of calves prior to leaving the dairy, characterize transport conditions, and determine how age at transport and transport duration impact health and behavior outcomes for non-replacement dairy calves (Cramer et al., 2024a). This study emphasized the necessity for improved decision-making regarding fitness for transport, implementing greater management strategies before transport, and considering trailer conditions when transporting non-replacement calves in the United States.

1.3 Challenges for the neonatal calf

Given that many calves in the United States are transported at less than one week of age (USDA, 2012; USDA, 2016), it is crucial to understand the specific challenges neonatal calves face, as these can exacerbate the adverse impacts of transport, intensifying the overall stress and potential health risks associated with early transport. Young calves have an immature immune

system, an underdeveloped hypothalamic-pituitary axis, and a reduced ability to thermoregulate, which impact how a calf responds to stress and potential pathogens (Godden et al., 2019; Eicher, 2001; Bernardini et al., 2012; Hulbert and Moisa, 2016). These underdeveloped physiological systems make calves particularly vulnerable to the stressors associated with transport, such as environmental changes, improper handling, and potential exposure to pathogens (Trunkfield and Broom, 1990), which can further compromise their health and overall well-being during and after transit.

Immature immune systems

Calves are born with immature immune systems and depend on the absorption of colostral IgG to achieve successful transfer of passive immunity (TPI) from the dam (Godden et al., 2019; Lombard et al., 2020). For the first few weeks of life, calves lack immunocompetence, with previous literature suggesting the adaptive immune system does not begin to mature until 21 days of age, resulting in a critical period in which calves rely on these maternal antibodies to protect them (Chase et al., 2008; Hulbert and Moisá, 2016). Effective colostrum management is crucial to ensure the successful transfer of passive immunity (TPI) and is one of the most impactful factors on a calf's health and survival (Urie et al., 2018; Godden et al., 2019). This is especially critical when preparing young calves for transport, as their underdeveloped immune systems increase the risk of disease due to factors such as commingling and exposure to novel pathogens (Lopez and Heinrich, 2022; Godden et al., 2019).

Passive immunity in calves is evaluated by measuring serum IgG or serum total protein (STP; Lombard et al., 2020). The current standard to determine TPI is a blood serum IgG concentration >10g/L or STP >5.1g/dL with a consensus recommendation that ≤10% of preweaned calves in a herd should have poor TPI (Godden et al., 2019; Lombard et al., 2020).

Poor TPI (<10g/L) in calves at the time of transport has been associated with increased morbidity and mortality as well as reduced growth and depressed attitudes in preweaned calves post-transport (Pardon et al., 2015; Wilson et al., 2020). Therefore, establishing good colostrum management practices for all calves on dairy operations is crucial to prevent negative outcomes in preweaned calves following transport (Cramer et al., 2024b; Godden et al., 2019; Raboisson et al., 2016).

Underdeveloped stress response

The hypothalamic-pituitary-adrenal (HPA) axis, which regulates the body's physiological response and adaptation to stress, is not fully developed in young calves, limiting their ability to mount an effective stress response (Mormède et al., 2007). Research has shown that adrenal reactivity to adrenocorticotropic hormone (ACTH) is less responsive in very young calves (Mormède et al., 1982). For example, Van Reenen et al. (2005) demonstrated that the cortisol response to exogenous ACTH was significantly lower in 3-week-old calves compared to 13-week-old and 26-week-old calves. As a final effector of the HPA axis, cortisol is released by the adrenal glands and plays a pivotal role in the negative feedback mechanism that helps regulate the stress response (Brown & Vosloo, 2017; Lynch, 2010). When the stress response fails to terminate effectively, it can lead to overstimulation and disrupt homeostatic systems, including immune function (Lynch, 2010; Brown and Vosloo, 2017). Chronic stress-induced immune impairment increases susceptibility to infections, as seen in cases like bovine respiratory disease (Brown and Vosloo, 2017; Carroll and Forsberg, 2007). Due to their distinct responses to these stressors compared to mature cattle, further research is necessary to gain a deeper understanding of how both acute and chronic stress affect calf health and welfare outcomes.

Lack of thermoregulation

Thermoregulation refers to the ability to maintain body temperature within a homeostatic range (Bligh, 1998). Preweaned calves are less tolerant of adverse weather conditions which challenges their ability to maintain body temperatures within their thermoneutral zone (Roland et al., 2016; Reuscher et al., 2024). The thermoneutral zone for a young calf range from 15°C to 26°C (Davis and Drackley, 1998; Wathes et al., 1983; Nonnecke et al., 2009; Spain and Spiers, 1996), with the lower critical temperature suggested to be 13.4°C (Davis and Drackley, 1998).

Previous work has reported ambient temperatures below -15°C and up to 30 °C while in transit (Schwartzkopf-Genswein et al., 2016; Cramer et al., 2024a), which are outside the thermoneutral zone of the calf (Davis and Drackley, 1998; Wathes et al., 1983; Nonnecke et al., 2009; Spain and Spiers, 1996). Preweaned calves are prone to heat loss under colder conditions due to a larger body surface area relative to their body mass, an undeveloped rumen, which does not yet produce body heat from ruminal fermentation, and little subcutaneous fat covering causing poor insulation (Roland et al., 2016; Collier et al., 1982; Reuscher et al., 2024). When temperatures fall below the lower critical threshold, calves must increase their rate of metabolic heat production to maintain thermal balance (Roland et al., 2016). This requires the expenditure of metabolic energy in young calves who already experience low energy reserves (Mormède et al., 1982; Todd et al., 2000). Heat stress from high temperatures also poses a challenge for young calves. Heat stress occurs when the body temperature of an animal increases, and they cannot dissipate enough body heat to maintain thermoneutrality (Morrison, 1983; Wang et al., 2020). Heat stress has been shown to negatively impact dry matter intake and growth performance in dairy calves as calves must allocate energy towards dissipating heat (Place et al., 1998; Nonaka et al., 2008; Lopez et al., 2018). Therefore, mitigating thermal stress through environmental

management, nutritional adjustments, and improved transport conditions is critical for ensuring the welfare and productivity of preweaned calves.

Dehydration and energy depletion

Preweaned calves are more susceptible to dehydration and energy depletion due to their limited energy stores at birth, including low body fat reserves, and, therefore, are highly dependent on external nutritional sources to meet their energy demands (National Academies of Sciences, 2021). This is critical during the first two to three weeks of life when the calf's digestive system is still immature but rapidly developing (Davis and Drackley, 1998). Milk and water deprivation during transport and marketing and the potential for increased energy expenditure during transport means that nutrition must be managed appropriately to reduce energy depletion and dehydration (Todd et al., 2000; Fisher et al., 2014; Roadknight et al., 2021a).

1.4 Transportation practices that affect calf welfare

Milk and water deprivation

Feed and water are often withheld during transport and because calves at the time of transport primarily consume a milk-based diet, fasting can increase their risk of dehydration and hypoglycemia (Creutzinger et al., 2021; Roadknight et al., 2021a). This is a common condition seen in young calves upon arrival to operations, with 32%-68% of veal calves showing clinical signs of dehydration and up to 73% being hypoglycemic (Scott et al., 2019; Pempek et al., 2017; Renaud et al., 2018; England et al., 2023). Dehydration is a welfare concern for calves because it can lead to metabolic acidosis, lethargy, and weakness, and has previously been associated with an increased risk of post-transport mortality (Roadknight et al., 2021a; Kasari, 1999; Pempek et

al., 2017; Renaud et al., 2018). As body energy reserves decline with increasing duration of feed withdrawal, calves must compensate by mobilizing stored body reserves, often resulting in a decline in body weight (Knowles et al., 1997; Fisher et al., 2014). In addition to the physiological effects of fasting, calves deprived of feed and water for prolonged periods most likely experience severe hunger and thirst (Creutzinger et al., 2021). Previous research has consistently indicated that calves are not receiving adequate feed and fluids either prior to transport at the dairy or during the marketing process (Cramer et al., 2024a; England et al., 2023; Pempek et al., 2017). Therefore, it is essential to improve feed and water provision at the dairy prior to transport and explore various strategies during transport to mitigate the risks of dehydration, hypoglycemia, and other welfare challenges.

Stocking density

Stocking density during transport is an important consideration when transporting calves, as overcrowding of young calves can result in injury and death (Jongman and Butler, 2014). Stocking density refers to the number of animals in a given space (Schwartzkopf-Genswein et al., 2012). Formal consensus recommendations for transport stocking density in the United States have historically been based on animal weight, however, quality assurance organizations state that the age and size of a calf should be considered when determining stocking density to ensure safety and welfare during transport (Schwartzkopf-Genswein et al., 2012; CCQA, 2022). Additionally, young calves have shown a greater preference to lie down during transit compared to mature cattle (Todd et al., 2000; Jongman and Butler, 2014; Knowles et al., 1997). Previous transport studies indicate that calves under a month old spend nearly 80% of their time in transit lying down (Cramer et al., 2024a; Marcato et al., 2020). To accommodate this, stocking density should be low enough to allow each calf enough space to lie down comfortably throughout the

journey (CCQA, 2022). Providing sufficient space for calves to lie down during transport can offer several benefits. It helps conserve body heat by minimizing the surface area for heat loss, reduces the energy demand for standing, and lowers the risk of muscle fatigue (Jongman and Butler, 2014; Uetake et al., 2011).

Previous research by Uetake et al. (2011) and Todd et al. (2000) indicates that stocking density influences lying behavior in calves. Uetake et al. (2011) found a higher proportion of calves laid down and turned around when transported at a low stocking density (0.45 m² per calf) compared to those transported at a high stocking density (0.24 m² per calf). This is in agreement with previous work conducted by Todd et al. (2000) in which an increase in lying time was observed for 5-to-10-day-old Holstein bull calves transported at a stocking density of 0.40 m^2 compared to 0.20 m^2 per calf. Furthermore, the number of posture changes (e.g., transitions between lying and standing) increased as stocking density decreased, with densities of 0.3–0.5 m² per calf allowing for more movement compared to 0.2 m² per calf (Jongman and Butler, 2014).

High stocking rates have been associated with increased muscle fatigue and damage in calves, as indicated by elevated creatine kinase (CK) activity. CK is an enzyme that can leak into the blood when muscle cells experience damage or stress, such as during physical trauma, exertion, or injury (Fisher et al., 2014; Todd et al., 2000). Calves transported with stocking densities less than 0.3m^2 per calf had greater CK activity compared to calves transported in lower stocking densities (>0.3m^2 per calf), suggesting reduced trauma to muscle cells (Todd et al., 2000; Jongman and Butler, 2014; Uetake et al., 2011). Prolonged standing during transport may contribute to muscle fatigue, and calves colliding or stepping on each other can result in muscle damage (Jongman and Butler, 2014). In contrast, a study conducted by Grigor et al. (2001)

found no notable differences in stability or injury between 10-day-old Holstein calves transported at a stocking density of 0.375m^2 per calf and 0.457m^2 per calf. The lack of notable difference between stocking densities could be due to both treatment groups being within ideal ranges identified in previous studies (Grigor et al., 2001; Todd et al., 2000; Jongman and Butler, 2014; Uetake et al., 2011). These findings suggest that low stocking densities (i.e., more space per calf) provide calves with greater freedom to exhibit natural behaviors that are critical for calf comfort and welfare during transportation, as they may help reduce stress and the risk of muscle fatigue and injury associated with restricted movement at higher stocking densities.

Ambient temperature

As aforementioned, preweaned calves have increased susceptibility to thermic stress when exposed to extreme weather conditions (Bernardini et al., 2012). Transporting calves during adverse weather, either in hot summer or cold winter conditions, presents unique challenges that affect their health and survival. Transporting calves in the summer has been shown to result in increased body temperatures and weight loss compared to other seasons, likely due to greater fluid loss (Bernardini et al., 2012). Previous literature also provides evidence that suggests calves exposed to higher ambient temperatures during the preweaning period experienced lower growth rates, lower immune function, higher serum corticosteroid concentrations, and higher mortality (Stott et al., 1976; Marrero et al., 2021; López et al., 2018; Renaud et al., 2018). In contrast, several studies have reported increased mortality risks in calves transported during colder seasons (Cave et al., 2008; Winder et al., 2016; Staples and Haugse, 1974). This is consistent with findings that mature cattle are more likely to die in colder temperatures, with the risk of mortality significantly rising when temperatures fall below -15°C (Gonzalez et al., 2012). The increased mortality in calves transported during the winter season can partially be attributed to

their inability to regulate body temperature effectively, as noted by Knowles et al. (1997). This is likely in part due to the calves' low energy reserves as a result of fasting during transport which limits their ability to generate enough heat to compensate for the loss of body heat in cold conditions (Roland et al., 2016; Fisher et al., 2014). Both extreme heat and cold present significant risks to preweaned calves during transport, as their limited energy reserves and ability to thermoregulate make them particularly vulnerable to temperature fluctuations. Therefore, careful consideration of weather conditions and appropriate mitigation strategies are crucial to protect calf health and reduce mortality risks during transit.

1.5 Transportation-associated risk factors for poor calf welfare

Pre-transport condition

Fitness for transport has been identified as a significant concern in livestock transportation (Grandin, 2001; Edwards-Callaway et al., 2019). Transporting unfit calves can exacerbate pain or discomfort and further deteriorate disease or injury (Cramer et al., 2024b). Quality assurance programs recommend against transporting calves with conditions such as diarrhea, respiratory disease, lethargy, dehydration, fractures, poor body condition, severe lameness, open wounds, or an inability to stand or walk with ease (CCQA, 2022). However, these recommendations are not mandated, thus many calves are still transported in poor condition. For example, it has previously been reported that 37–52% of calves had at least one health abnormality directly before transport (Cramer et al., 2024a; Wilson et al., 2020). Calf condition at the time of loading is an important risk factor that has been associated with greater incidences of morbidity (Wilson et al., 2020). For example, calves with navel inflammation prior to transport were more likely to be treated for diarrhea within the two weeks following transport, while those displaying depressed attitudes before transport had higher odds of mortality during

the same period (Wilson et al., 2020). The quality of care provided to calves on the dairy plays a critical role in their health outcomes, as transporting unfit calves likely contributes to the high morbidity and mortality rates observed upon their arrival at receiving operations (Wilson et al., 2020; Cramer et al., 2024a; England et al., 2023). Further research is necessary to assess the implementation of fitness for transport recommendations on United States dairies, identify adherence gaps, and continue to examine how calf condition prior to transport affects health and welfare during and after transport.

Distance and duration

The duration of transport can pose as a risk factor for poor welfare because it determines how long calves are exposed to transportation-related stressors (Buckham-Sporer et al., 2023). In industry practices, the exact time spent in transit is not typically recorded, making it challenging to accurately assess its impact. As a result, transport distance is often used as an approximate measure (Cave et al., 2005). Transport distance can vary widely, from less than 5 miles to over 100 miles (USDA, 2016). Under U.S. livestock transportation regulations, calves may be in transit for up to 28 hours without access to feed or water (United States Code, 1994). Due to the lack of specific regulations for calf transport in the United States and limited data, the exact transport distances and durations are largely unknown. Various studies have investigated the negative impacts of prolonged transport distances and durations on calves (Todd et al., 2000; Fisher et al., 2014; Roadknight et al., 2021b; Marcato et al., 2020; Goetz et al., 2023a). Transport lasting 12 hours or more, or covering distances exceeding 400–500 km, has been associated with metabolic changes and an increased risk of mortality in young calves (Todd et al., 2000; Fisher et al., 2014; Cave et al., 2005; Roadknight et al., 2021b).

Longer times in transit may increase calves' risk for physical trauma as demonstrated by elevated levels of CK, an indicator of muscle cell damage (Fisher et al., 2014; Todd et al., 2000). Roadknight et al. (2021b) found that 36% of calves had elevated CK after transport compared to non-transported calves. Elevated CK levels may indicate that calves were unable to rest during transport, causing skeletal muscle trauma and extra energy stores to be exerted to maintain balance and posture during transport (Knowles et al 1997). Furthermore, it has been suggested that more time spent in transit also increases the risk of muscle cell damage resulting from collisions between animals or with equipment (Fisher et al., 2014).

Three blood parameters used in studies to determine that extended time in transit (16-30 hours) decreases body energy reserves are: decreased blood glucose, increased non-esterified fatty acids (NEFA), and increased beta-hydroxybutyrate (BHB; Todd et al., 2000; Knowles et al., 1997; Marcato et al., 2020; Goetz et al., 2023a). These physiological changes are likely due to a combination of transportation stressors, such as withholding feed and water and greater expenditure of energy reserves due to stress, thermoregulation, and standing for prolonged periods (Mormède et al., 1982; González et al., 2012; Creutzinger et al., 2021). While prolonged transport durations can exacerbate these stressors, many physiological and metabolic changes recorded in previous research appear to be primarily affected by fasting rather than transport itself (Fisher et al., 2014; Roadknight et al., 2021b). Goetz et al. (2023a) found a considerable decrease in blood glucose concentration directly after transport for calves transported 16 hrs compared to 6 hrs, which suggests calves are at a greater risk for hyperglycemia when subject to longer transport durations without access to feed and water. For calves transported over 500 km, data suggested each additional km traveled was associated with a greater decline in glucose compared to calves traveling shorter distances (Roadknight et al., 2021b). Goetz et al. (2023a)

also reported that immediately after transport, BHB and NEFA concentrations were substantially higher in calves transported for 16hrs compared to calves transported for 6hrs. Blood BHB is a by-product of energy metabolism when the body utilizes stored fat reserves for energy (Fisher et al., 2014). This suggests that calves transported for longer durations may experience greater metabolic stress and rely more on stored fat reserves to maintain homeostasis. Elevated blood NEFA levels indicate a negative energy balance, showing that a calf's energy reserves have been mobilized due to insufficient feed intake to meet energy demands. This energy mobilization leads to weight loss, a critical concern for young calves as their body fat reserves are already minimal (Fisher et al., 2014; Knowles et al., 2014). These findings may suggest that while extended transit alone may not significantly impact metabolic changes and blood parameters, its combination with feed and water deprivation appears to substantially increase the risks for adverse outcomes for young calves (Fisher et al., 2014; Mormède et al., 1982). Further studies examining the effects of nutrition and feed deprivation, along with their relationship to transportation, would help clarify whether these outcomes are due to transport, extended fasting, or a combination of both (Roadknight et al., 2021a).

Age at transport

Age at transport has been associated with lower weight at arrival to their destination and reduced growth and carcass performance following transport compared to their older counterparts (Rot et al. 2022; Goetz et al., 2023b; Marcato et al 2022b). For example, when calves were transported at 5 days of age or younger, they had lower body weights upon arrival compared to calves transported at over 5 days old (Rot et al. 2022). Goetz et al. (2023b) found age at transport was positively associated with ADG where calves transported at 2-4 days of age had reduced growth following transport compared to older calves. Furthermore, age at transport

was found to have a significant effect on carcass weight where calves transported at 14d had lower carcass weights at slaughter compared to calves transported at 28d (Marcato et al., 2022b).

Age at transport has also been associated with differences in health and immune status (Marcato et al., 2022a; Goetz et al., 2023b). In a study comparing the impacts of transport by age, Marcato et al. (2022a) reported calves transported at 28 days showed a more advanced development of their adaptive and innate immunity, indicated by higher lymphocyte counts and lower neutrophil counts, compared to those transported at 14 days, though values remained within normal reference ranges. These findings suggest that older calves may be better equipped to cope with and respond to stressors, likely due to their more mature immune systems. For example, elevated lymphocyte counts in older calves may reflect greater resilience to stressors, such as those associated with transport (Marcato et al., 2022a). Furthermore, previous research has linked elevated lymphocyte counts to a decreased risk of morbidity and mortality in young calves (Konigslow et al., 2020). Conversely, elevated neutrophil counts in young calves have been linked to a more than five times increase in the risk of mortality (Konigslow et al., 2020).

The immature immune system of young calves makes them highly vulnerable to disease, as they are less resilient to stressors and have a reduced capacity to adapt and mount effective immune responses (Chase et al., 2008). Diarrhea is of particular concern in the industry because it has a stronger association with mortality than other diseases, including respiratory disease (Pardon et al., 2013). Calves transported at a younger age have been shown to exhibit a higher incidence of abnormal fecal scores and are more prone to diarrhea compared to their older counterparts. In a study by Goetz et al. (2023b), calves who were 15-19 days old at transport had a lower incidence of abnormal fecal scores compared to calves transported at 2-6 days of age. Additionally, these calves had a reduced incidence of diarrhea at the time of departure from the

origin farm (Goetz et al., 2023b). These results align with the findings of Marcato et al. (2022b), who found calves transported at 14 days old had a greater prevalence of diarrhea on the day before transport compared to calves transported at 28 days old. Younger age at transport has been consistently shown to have significant implications for post-transport performance, growth, carcass characteristics, and overall health (Rot et al., 2022; Goetz et al., 2023b; Marcato et al., 2022a,b). Waiting to transport calves until they are older has been proposed as one way to reduce the impact of transportation (Cramer et al., 2024b). However, additional research is needed to define the optimal transport age for calves.

1.6 Mitigating the impacts of transportation

Implementing preconditioning practices within the dairy sector has been identified as a potential strategy to improve calf health during and after transport (Cramer et al., 2024b). Preconditioning, a term first introduced in the beef sector, is a set of management practices intended to prepare the animal for the next phase of production (Hilton, 2015). Preconditioning for the young dairy calf should focus on practices that prepare a calf to be successful during and after transport (Cramer et al., 2024b). Certain practices, like vaccinations, may be less feasible for dairy operations to implement, as calves are often transported before reaching the appropriate age for certain vaccinations (Chase, 2022; USDA, 2016). Vaccinating young calves can present a challenge because maternal antibodies from colostrum can interfere with the calves' ability to mount an active immune response, reducing vaccine efficacy (Chase et al., 2008). However, when administered at the appropriate time and under optimal management conditions, vaccines can still contribute to improved calf health and lower disease risks during the pre-transport period.

Administering nonsteroidal anti-inflammatory drugs (NSAIDs) such as meloxicam at the time of transport could offer calves sustained relief during the transport event and aid in their recovery afterward, as previously demonstrated in older beef steers (Van Engen et al., 2014). For example, Chibisa et al. (2018) found that young Jersey calves given meloxicam before transport showed improved milk replacer intake and higher average daily gain (ADG) compared to control groups. By reducing stress and discomfort, NSAIDs may facilitate better recovery of weight loss by supporting feeding behavior and improving ADG. This suggests that the use of NSAIDs such as meloxicam can serve as a valuable mitigation strategy to support calf recovery post-transport. Further research is needed to validate these findings and optimize their use in transportation protocols.

Prior research on rehydration strategies has focused primarily on treating diarrhea in young calves (Smith, 2009; Constable et al., 2020; Taylor et al., 2017), and data suggests various rehydration strategies can effectively support calves by replenishing fluids and electrolytes lost during diarrheal episodes (Smith, 2009). Given that dehydration, diarrhea, and hypoglycemia are common health concerns identified in calves upon arrival at operations (Pempek et al., 2017; Renaud et al., 2018; England et al., 2023; Maggard et al., 2023), there is a strong rationale for further exploration in the use of rehydration therapy as a strategy to mitigate the impacts of transport-related stress on calf health.

Recent literature has explored how different oral therapies and treatment durations can aid in calf recovery following transport (Pempek et al., 2024; Cockram et al., 2024; Bajus et al., 2024). Treatment length has been explored in which Pempek et al. (2024) found that providing oral electrolyte therapy to young dairy calves for two consecutive days after transport significantly improved moderate dehydration compared to calves that did not receive electrolyte therapy.

Cockram et al. (2024) compared the effectiveness of three different liquid diets in restoring energy and water deficits following transport for preweaned male Holstein calves. They found that a glucose-electrolyte diet was better able to assist in recovery from dehydration in the short term, but a milk replacer and whey-based diet provided sufficient nutrient energy to support recovery and maintain blood glucose long-term. Similarly, Bajus et al. (2024) found a milk replacer diet was beneficial in reducing fat mobilization during transport and reducing number of days with diarrhea and respiratory disease when compared to oral rehydration solutions. These results suggest that post-transport recovery in young calves can be optimized by tailoring liquid diets to address specific needs.

Rest periods are currently utilized in legislation to help mitigate the impacts of transport. For example, the United States limits livestock transport to 28 hours before requiring a stop for five consecutive hours of rest (United States Code, 1994). Specifically for calves, the European Union limits transportation to nine hours, and an additional nine hours of transport is acceptable after a one-hour rest period (Council of the European Union, 2004). However, there is a lack of scientific evidence to support this legislation (Jongman and Butler, 2014). A recent study by Goetz and Renaud (2024) investigated the effects of providing an 8-hour rest period during a 16-hour transport on calf health, growth, and behavior. The study found that calves given a rest period experienced less weight loss compared to the control group, which was expected as the calves that received a rest period had access to feed and water during that time. However, aside from this benefit, minimal differences in health and growth were observed between the treatment groups (Goetz and Renaud, 2024). These findings are supported by previous research on weaned beef calves, which reported little variation in short-term and long-term outcomes across different rest period durations mid-transport (Melendez et al., 2022; Marti et al., 2017). An important

finding from this study was that calves provided with a rest period spent a greater proportion of time lying down the day after arrival compared to the control group. This behavior may suggest that calves in the rest-period group were more fatigued, likely due to the extended total travel duration resulting from the inclusion of the rest period (Goetz and Renaud, 2024).

In a commercial setting, rest stops can present greater challenges due to the large number of calves being transported (Knowles et al., 1997). Ensuring that all calves are adequately fed during stops can be logistically difficult (e.g., mixing milk replacer or oral electrolytes, record keeping, biosecurity). Moreover, young calves do not display herding behavior, so moving large groups of calves can be difficult and could increase the risk of injury and stress from poor handling (Jongman and Butler, 2013). Additionally, rest stops introduce opportunities for commingling within and between groups, which can further elevate stress levels and increase the risk of pathogen exposure (Wilcox et al., 2013; Roadknight et al., 2021a). Therefore, implementing rest stops may not be the most effective strategy for mitigating the impacts of transport on calves, as the marginal benefits may be outweighed by the logistical challenges and the additional stress calves experience during unloading and reloading (Knowles et al., 1997).

Minimum age at transport is also a mitigation strategy utilized by legislation in neighboring dairy industries (Council of the European Union, 2004; Animal Health Australia, 2012; New Zealand Government, 2018). While older age at transport has been shown to have benefits for calves in transport (Rot et al., 2022; Goetz et al., 2023a; Marcato et al., 2022b), these practices may be harder to implement in operations in the United States (Cramer et al., 2024b). Moreover, the optimal age for transporting calves remains unclear and requires further exploration before it can be effectively implemented in practice.

1.7 Gaps in knowledge and conclusion

Transportation exposes young calves to various stressors during a critical period in which their physiological immaturity limits their ability to cope, heightening the risk of adverse health and welfare outcomes during and after transport (Roadknight et al., 2021a). A recent scoping review identified several gaps in the literature surrounding methods to prepare calves for transportation, such as improving nutrition, administering medication or supplementation, or transporting calves at an older age (Goetz et al., 2022). Additionally, much of the existing literature regarding calf transportation and marketing is based on dairies, calf operations, auctions, and abattoirs in Canada, Australia, and the Netherlands (Renaud et al., 2018, 2020a; Goetz et al., 2023a,b; Jongman and Butler, 2014; Cave et al., 2005; Marcato et al., 2020). The United States dairy industry is different compared to these countries, with limited transport legislation, larger herds, and a high-efficiency farm model, highlighting the need for new research that applies to the United States dairy industry (Douphrate et al., 2013; United States Code, 1994). Given the variability in management practices at source dairies and the health and welfare challenges identified throughout transportation and marketing, coupled with the increasing value of non-replacement calves, it is essential to explore across all stakeholders to identify sustainable solutions that support animal welfare while promoting industry sustainability (Bolton and von Keyserlingk, 2021). More research is needed to identify the factors that are both most effective in improving calf condition and feasible to implement (Cramer et al., 2024b). Improving our understanding of calf transportation practices in the United States can help guide future exploration of alternative calf transport management strategies that promote the health and welfare of dairy calves and support the long-term viability of the dairy industry. Therefore, this thesis seeks to address the following gaps in the literature through a survey to (1) describe the

current industry practices regarding the transportation of preweaned dairy and beef-on-dairy crossbred calves, (2) determine differences in pre-transport management on dairies between replacement heifers, beef-on-dairy crossbreds, and dairy bull calves, and (3) identify outreach and research needs to address calf welfare concerns related to transportation.

TABLES

Table 1.

Country	Minimum age for transport	Maximum duration of transport	Maximum time allowed off feed while in transit	Reference
Australia	5[1]	12	Not legislated at national level	Animal Health Australia (2012)
Canada	Not legislated at national level[2]	12	12	Government of Canada (2022)
European Union	14[3]	9[4]	19	Council of European Union (2004)
New Zealand	4	12	24	New Zealand Government (2018)
United States	Not legislated at national level	28	28	United States Code (1994)

Modified from Roadknight et al., 2021a

[1] Calves <5 d old may be transported up to 6 hours but not to a sale yard or abattoir

[2] Calves ≤ 8 d old and without dam can only be transported once and not to an assembly yard

[3] If traveling more than 8 h. Calves < 10 d can travel up to 100km

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CHAPTER 2: PREWEANED CALF TRANSPORTATION PRACTICES IN THE UNITED STATES: A SURVEY OF DAIRIES, CALF RAISERS, AND HAULERS

2.1 Introduction

Effective early-life management is essential for promoting dairy calves' long-term health, productivity, and welfare. Transportation has recently gained recognition as a significant challenge among the various management practices that young calves experience early in life (Alley et al., 2020; Creutzinger et al., 2021; Roadknight et al., 2021; Cramer et al., 2024b). Transportation presents stressors like food deprivation, commingling, improper handling, and extreme weather conditions, which are especially challenging to calves due to their underdeveloped immune systems and limited stress response (Trunkfield and Broom, 1990; Pardon et al., 2015; Hulbert and Moisá, 2016). In the United States, transporting young calves from dairies is common practice, with an estimated 6 million calves sold and shipped annually (Cramer et al.,2024a; Edwards-Callaway et al., 2019; Bolton and von Keyserlink, 2021; USDA, 2024). While the challenges of transporting young calves are well-documented, there is limited information on the specific transport practices used in the United States (Creutzinger et al., 2021). This knowledge gap limits efforts to evaluate and mitigate the impacts of transport on calf health, welfare, and performance, highlighting the need for detailed data to guide improvements in practices and outcomes. This paper aims to address this knowledge gap by collecting data at various stages of the transport process, from preparation on the dairy to the final destination. Understanding pre-transport management practices at the dairy is essential for identifying the best ways to prepare calves for successful transport and recovery. Input from transporters and calf raisers is also important, as transporters influence the conditions calves experience during transit, while calf raisers are responsible for their care and recovery upon arrival.

Management practices often differ between replacement and nonreplacement calves, especially male calves (Shivley et al., 2019; Creutzinger et al., 2021; Cramer et al., 2024b). Male dairy calves have traditionally been considered low value, which may influence lower standards of care compared to female calves on dairies (Cave et al., 2005; Creutzinger et al., 2021). The increased use of beef semen in dairy cows to produce beef-on-dairy crossbred calves, driven by the growing interest from the beef sector, has led to a rise in the number of beef-on-dairy calves leaving the dairy (Felix et al., 2023; McCabe et al., 2022; Creutzinger et al., 2022). As more of these calves leave the dairy to transition into different production systems, it is necessary to understand their unique management and marketing challenges to ensure good health, welfare, and performance.

Improving calf health and welfare requires a multifaceted approach influenced by each sector of the supply chain, beginning at the dairy with optimal pre-transport management, ideal transport conditions provided by the transporters, and optimal calf health management upon arrival to their destination. Achieving this will require a comprehensive understanding of each sector to guide improvements effectively. Therefore, the objectives of this study are to (1) describe the current industry practices regarding the transportation of preweaned dairy and beef-on-dairy calves, (2) determine differences in pre-transport management on dairies between replacement heifers, beef-on-dairy, and dairy bull calves, and (3) identify outreach and research needs to address calf welfare concerns related to transportation.

2.2 Materials and methods

This research was approved through the Colorado State University (CSU) Institutional Review Board (#4250) prior to project initiation.

Participant population and recruitment

The target population for this survey was individuals making decisions about transporting and receiving preweaned dairy or beef-on-dairy calves within the United States. This population could include producers, owners, operators, managers, employees, or veterinarians who work on dairies, calf ranches, heifer-raising facilities, auctions, and veal operations, as well as drivers who transport calves between these sites. Participant recruitment began in March 2023 and ended in January 2024. In-person recruitment began at the Dairy Calf and Heifer Association (DCHA) conference hosted in Prior Lake, MN in March 2023. Participants were recruited via email, newsletters, and website pages from industry and extension groups such as DCHA, Progressive Dairy, Hoards Dairyman magazine, and the University of Wisconsin-Madison Extension. The survey was offered in online and hard copy format for distribution purposes. Respondents were offered a $15 gift card for their participation. Those who completed the survey and chose to receive a gift card were directed to a separate link to provide their email address to maintain confidentiality. No identifying information was associated with responses. The sample size was based on the availability of respondents, and no formal sample size calculation was completed, given the paucity of existing calf transport data in the United States.

Survey format and content

The survey was developed by a research team with expertise in animal welfare, calf health and management, veterinary medicine, statistics, and survey development and analysis. The survey was entered into an online survey software (Qualtrics XM Platform, Qualtrics International Inc., Seattle, WA) to facilitate online distribution. Before distribution, survey questions were reviewed by the research team, practicing veterinarians, and industry professionals who work closely with dairies or calf ranches to ensure clarity and validity. Survey

logistics (i.e. branching, clarity, flow) were tested by three graduate students from the CSU Department of Animal Sciences to ensure usability and function. The survey used a branching method to direct respondents to complete one of four surveys, each containing different sets of questions based on their selected role in the management and transportation of preweaned calves. Possible roles that participants could select included: 1) dairies that sell or contract out calf raising for preweaned calves, 2) dairies that transport and raise preweaned calves at another location, 3) operations that receive preweaned calves after transport (e.g., auctions, livestock markets, calf ranches, etc.), and 4) haulers that transport preweaned calves. Respondents were required to select one role that best described their operation. The number of survey questions varied based on the respondent's role. Respondents working on dairies that sold or contracted out calf raising for preweaned calves received a survey with 28–69 questions focused on pre-transport practices, including colostrum management, health evaluations, and preconditioning, a term used to define management practices designed to prepare an animal for the next phase of production (Hilton, 2015). These questions addressed practices tailored specifically for preweaned replacement heifers, beef-on-dairy calves, and dairy bull calves. Respondents working on dairies that transported and raised preweaned calves at a different location received a survey with 32–78 questions, which included the same pre-transport topics as well as additional questions about the calves' condition upon arrival at their destination. Respondents who worked on operations that received preweaned calves completed a survey with 27–30 questions focusing on calf condition upon arrival, the source of calves, and preconditioning requirements. Haulers who transported preweaned calves received a survey containing 16–18 questions about transport practices, including travel distance and duration, the number of stops per trip, and the calves' source and destination. Respondents from dairy operations that raised all calves on-site without

transporting them prior to weaning were directed to the end of the survey, and no further data was collected from them. All respondents that indicated involvement in the management and transport of preweaned calves within the last year received questions about training, demographics, as well as challenges and opportunities relating to calf transportation. Question types included multiple-choice, select-all-that-apply, Likert scale, and free response. The survey was designed to take between 15-20 minutes, with exact times varying based on participants' responses. Respondents could stop the survey at any time, in accordance with IRB protocol. The only required questions were to confirm respondents were over 18 years old and consented to participate in the study. All surveys are available in Supplementary Material.

Bot protection and detection

Security measures were implemented in the survey using Qualtrics security settings to prevent fraudulent responses from online channels. This included Google's Completely Automated Public Turing Test to tell Computers and Humans Apart (reCAPTCHA) V3, which evaluates criteria such as typing speed and IP address activity (Google Developers 2020; Qualtrics 2021; Griffin et al., 2022). Additionally, bot detection, which is a Qualtrics survey field that indicates a reCAPTCHA score that relates to the probability that the respondent is a bot, and password protection were applied to further secure the survey (Griffin et al., 2022). However, similar to previous reports, sophisticated bots were still able to bypass these security measures (Griffin et al., 2022; Godinho et al., 2020; Teitcher et al., 2015). The initial data collection was compromised on May 1st, 2023. A surge of survey responses in a 24-hour time frame alerted the research team to the survey breach. The research team was able to confirm fraudulent responses by analyzing the respondents' provided email addresses as described in previous literature (Griffin et al., 2022; Storozuk et al., 2020; Teitcher et al., 2015). After initial bot detection, the

survey was closed, and data collection was paused on May 2nd, 2023. In the second wave of data collection, the recruitment strategy was modified to have multiple unique survey links (the questions remained the same) to be shared through specific distribution channels so that any additional data breaches could be traced back to the distribution channel source and addressed without compromising other channels. This allowed the research team to detect additional bot responses from an individual survey link on October 19th, 2023.

Data cleaning

The research team used a two-part data cleaning protocol modified from previous literature (Griffin et al., 2022; Storozuk et al., 2020; Teitcher et al., 2015). The first stage of the data cleaning protocol was performed in Qualtrics utilizing the filter feature (Qualtrics, Provo, UT, USA, 2020). The filter feature was used to remove responses that did not complete at least 70% of the survey (Griffin et al., 2022) and responses with a reCAPTCHA score less than 0.5, as suggested by Google's developer guide (Google Developers 2020, Mountain View, CA; Qualtrics 2021). After filtering was completed in Qualtrics, all cleaned data was exported into Microsoft Excel spreadsheet (Microsoft Corporation, Redmond, WA, USA). All data was filtered to identify and remove all survey responses recorded between May 1st and 2nd and October 19th, 2022, due to the recorded bot compromise. Respondents that indicated their operation was located outside of the United States in the demographics question were also removed. Lastly, the remaining responses were checked for conflicting data as described in Griffin et al. (2022). These included inconsistencies in demographic and population responses (e.g., respondents who report transporting over 1000 preweaned calves from their dairy in the last year and also report having 80-200 head of lactating cows).

Data processing and statistical analysis

For statistical analyses, categories with fewer than five responses were combined with the closest similar category. Age categories "4-7 days," "7-14 days," and "≥14 days but before weaning" were merged into a single category "≥4 days." Total colostrum categories "2 quarts" and "3 quarts" were merged into a single category "<4 quarts". Lastly, timing of colostrum categories "3-4 hours" and ">4 hours" were merged into "≥3 hours." Colostrum quality was removed from statistical analysis due to categories having fewer than five responses and being unable to combine categories. Written responses in the "Other" category were categorized if applicable. For example, "physical markings on calves" was categorized into "paint or chalk marks" responses for colostrum verification. Additionally, written responses that could clearly be recategorized, such as "calves are transported 4 hours after the 3rd bottle" were categorized as "No" to the question of regarding whether calves have access to milk feeding within 2 hours prior to transport. Written responses that were vague or could not be recategorized (e.g., "depends," "not sure," "feed 3 times a day") were excluded from analysis for that variable. Missing responses were excluded for each question, resulting in different sample sizes for questions. Statistical analysis was performed in R Software (v4.4.0, R Core Team, 2021) and summary statistics were calculated for all variables.

For objective 1, descriptive summaries of current industry practices regarding the transportation of preweaned dairy and beef-on-dairy crossbred calves were reported for each calf class in frequency tables.

For objective 2, statistical analyses using paired data were conducted to determine differences in management practices at the dairy prior to transport. The predictor of interest was calf class (categorical; replacement heifer, beef-on-dairy, dairy bull). Statistical analysis was

performed for each outcome variable of interest using either Bhapkar, Kruskal-Wallis, or McNemar tests. For each analysis between the predictor (calf class) and the outcome of interest, three pairwise tests were performed between the three calf classes. The first test compared replacement heifers with beef-on-dairy, the second compared replacement heifers with dairy bull calves, and the third compared beef-on-dairy with dairy bull calves. Bhapkar tests were performed for the outcome variables age (categorical; <24 hours, 1 day, 2 days, 3 days, ≥4 days) and timing after birth to first colostrum feeding (categorical; <1 hour, 1-2 hours, ≥3 hours) to compare for difference in practices between the predictor variable (calf class). A Holm-Bonferroni correction was applied to account for multiple comparisons. Kruskal-Wallis tests were performed for the outcome variables median distance (continuous), median duration (continuous), and incentive for improve colostrum decisions (continuous) with Holm-Bonferroni correction to compare for difference in practices between the predictor variable (calf class). Finally, McNemar tests were performed for the outcome variables total colostrum quantity (categorical; <4qts, ≥4qts), milk feeding prior to transport (categorical; yes, no), and access to water immediately prior to transport (categorical; yes, no) following the same procedure used for the previous two tests. Significance was defined as p-value ≤ 0.05. Bhapkar, Kruskal-Wallis, and McNemar tests were used to analyze paired data, so only dairy operations with multiple comparisons (i.e., transported more than one calf class type) and that responded for a given set of questions (e.g., age at transport, timing of colostrum, average distance, average duration, colostrum quantity, milk feeding prior to transport, access to water prior to transport, fitness for transport, and preconditioning practices) were included in analysis.

For objective 3, outreach and research needs to address calf transport welfare concerns were summarized using frequency tables to report common challenges and resources identified in each industry sector.

2.3 Results

Overview of responses

A total of 936 responses were collected, and 781 (83%) responses were removed. Specifically, 316 responses were removed for completion rates less than 70%, 278 responses were removed for reCAPTCHA scores less than 0.5, 289 responses were removed for bot suspicion, and 239 responses were removed for bot detection. These categories were not mutually exclusive. Due to the nature of the survey distribution through various media sites, the exact response rate is unknown. In the end, 152 (16%) total responses were accepted for analysis; 29 operations identified as dairies that did not transport calves prior to weaning and were excluded from further analysis, thus, a total of 123 (13%) responses were accepted for final analysis. The final 123 responses accepted for analysis consisted of 69 dairy operations that transported preweaned calves, 29 operations that received preweaned calves, and 25 hauling companies that transported preweaned calves in 2022. Of those 69 dairy operations, 33 contracted out their calf raising at another location or sold some or all preweaned calves (i.e., calves were transported to a facility they did not own), and 36 raised their calves with at least some of these preweaned calves transported to another location they owned.

Demographics for all respondents

Most operations were located in the Midwest (51.2%, 63/123), followed by the West (19.5%, 24/123), Northeast (11.4%, 14/123), Southwest (5.7%, 7/123), and Southeast (4.1%,

5/123). Eight percent of operations did not define their region (8.1%, 10/123). The majority of respondents identified as male (52.8%, 65/123), between the ages of 30-39 (24.4%, 30/123) or 40-49 (25.1%, 31/123), and were owners (48.0%, 47/98) or managers (35.7%, 35/98) at their operation.

Dairy pre-transport practices for replacement heifer, beef-on-dairy, and dairy bull calves

Forty dairy operations transported 284,597 replacement heifers, 58 dairy operations transported 263,104 beef-on-dairy crosses, and 57 dairy operations transported 33,146 dairy bull calves prior to weaning. Thirty-six operations transported replacement heifers and beef-on-dairy calves, 31 operations transported replacement heifers and dairy bull calves, and 49 operations transported beef-on-dairy and dairy bull calves.

The majority of dairy operations (82.5%, 31/40) in our study transported their replacement heifers to a calf ranch or heifer raising facility. In contrast, only 35.1% (20/57) of operations transported beef-on-dairy calves, and 21.8% (12/56) of operations transported dairy bull calves to a calf ranch or heifer raising facility. Operations transported beef-on-dairy calves (33.3%, 19/57) and dairy bull calves (41.1%, 23/56) to an auction or livestock market. Additionally, 24.6% (14/57) of operations transported beef-on-dairy calves, and 28.6% (12/56) transported dairy bull calves to a calf jockey or dealer. The age at transport that all operations reported for the majority of calves by calf class is described in Table 1. Operations reported a difference in age at transport between replacement heifer and beef-on-dairy calves (Table 2), replacement heifer and dairy bull calves (Table 3), and beef-on-dairy and dairy bull calves (Table 4), respectively (All $P < 0.009$).

Producers were asked to report the average distance and duration traveled for the majority of calves that left their operation. The median distance was 50 miles (1st Quartile: 15, 3rd Quartile: 450), 40 miles (1st Quartile: 15, 3rd Quartile: 70), and 30 miles (1st Quartile: 15, 3rd Quartile: 45) for replacement heifer calves, beef-on-dairy, and dairy bull calves, respectively. There was no difference in distance traveled between calf classes (All $P \geq 0.4$). Additionally, there was no difference in the duration of travel between calf classes, whereby median travel duration was 1.25 hours (1st Quartile: 0.875, 3rd Quartile: 8.5), 1 hour (1st Quartile: 0.5, 3rd Quartile: 2.0), and 1 hour (1st Quartile: 0.5, 3rd Quartile: 1.0) for replacement heifer, beef-on-dairy, and dairy bull calves respectively (All $P > 0.7$).

All but one dairy operation reported feeding colostrum to all calves regardless of class, with the exception being one operation that provided colostrum to replacement heifer and beef-on-dairy calves but not to bull calves. Overall, similar practices in total colostrum amount were reported across calf classes with 77.5% (31/40), 75.9% (44/58), and 76.8% (43/56) of operations provided ≥4qt (1 gal/4L) of colostrum to replacement heifers, beef-on-dairy, and dairy bull calves respectively (All $P = 1$). Timing after birth to the first colostrum feeding is reported in Table 5. A difference in colostrum timing was seen between replacement heifer and beef-on-dairy calves ($P = 0.02$; Table 6). A difference in colostrum timing was seen between replacement heifer and dairy bull calves ($P = 0.02$; Table 7). No difference in colostrum timing was seen between beef-on-dairy and dairy bull calves ($P = 0.2$; Table 8). Operations provided colostrum with a BRIX reading ≥ 22 (IgG>50g/L) to replacement heifer (39.1% 27/40), beef-on-dairy (51.7%, 30/58), and dairy bulls calves (45.5% 25/56). Over half of the operations utilize paper records to verify colostrum for replacement heifers (59.0%, 23/39), beef-on-dairy (56.9%, 33/58), and dairy bull calves (53.6%, 30/56).

Respondents were asked what factors would influence their decision to improve colostrum practices for each calf class. Approximately half of respondents reported they already had an excellent colostrum program in place for replacement heifers (52.5%, 21/40), beef-on-dairy (51.7%, 30/58), and dairy bull calves (46.4%, 26/56). Respondents reported that improvements to calf health would help influence their decision to improve colostrum practices for replacement heifers (65.0%, 26/40), beef-on-dairy (53.4%, 31/58), and dairy bull calves (50.0%, 28/56). Additionally, employee training would influence operations' decision to improve colostrum practices for replacement heifer (30.0%, 12/40), beef-on-dairy (32.8%, 19/58), and dairy bull calves (26.8%, 15/56).

There was no difference in the percentage of operations that reported providing milk within 2 hours prior to transport for replacement heifer (66.7%, 24/36), beef-on-dairy (69.8%, 37/53), or dairy bull calves (All $P = 1$; 76.9%, 40/52). There was no difference in the percentage of operations that reported providing access to water immediately prior to transport for replacement heifer (50.0%, 19/38), beef-on-dairy (45.6%, 26/57), or dairy bull calves (All $P \geq 0.2$; 52.7%, 29/55).

Preconditioning practices that all operations reported for the majority of calves on their operations, by calf class, are outlined in Table 9. Operations reported a significant difference in vaccination practices between replacement heifer calves and beef-on-dairy calves ($P < 0.05$; Table 10), as well as between replacement heifer calves and dairy bull calves ($P < 0.05$; Table 11). There was no difference in any preconditioning practices reported by operations for beef-on-dairy and dairy bull calves ($P > 0.05$; Table 12). Respondents were asked whether their operation would be willing to implement additional preconditioning practices to their current management

protocol; the majority of operations indicated yes or maybe for replacement heifers (81.6%, 31/38), beef-on-dairy (89.4%, 50/56), and dairy bull calves (89.1% 49/55).

Most operations conducted a formal health evaluation prior to transport for replacement heifer (66.7%, 26/39), beef-on-dairy (70.2%, 40/57), and dairy bull calves (68.5%, 37/54). Fitness for transport criteria across all calf classes is reported in Table 13. There were no differences in fitness for transport criteria reported between replacement heifer and beef-on-dairy (Table 14), replacement heifer and dairy bull (Table 15), and beef-on-dairy and dairy bull calf classes (All $P \geq 0.02$; Table 16).

Post transport practices for dairies that raised their own calves

Respondents that indicated they worked on dairies that transported and raised preweaned calves at another location (52.2%, 36/69) were asked about the practices performed for those preweaned calves immediately after transport. Seventy-nine percent (15/19) of operations conducted a formal health assessment and 57.9% (11/19) collected blood samples to determine transfer of passive immunity for calves upon arrival to their facility. The condition of preweaned calves upon arrival is outlined in Table 17. Across all dairy operations, the median percentage of preweaned calves that arrived at operations affected by gastrointestinal issues such as diarrhea was 16.0% (1^{st} Quartile: 7.0%, 3^{rd} Quartile: 20.0%). The median percentage of preweaned calves affected by respiratory problems such as pneumonia was 10.0% (1^{st} Quartile: 6.25%, 3^{rd} Quartile: 26.5%), and 3.0% (1^{st} Quartile: 2.0%, 3^{rd} Quartile: 6.5%) were affected by navel infections or inflammation. Additionally, respondents reported that about 5.0% (1^{st} Quartile: 3.0%, 3^{rd} Quartile: 13.8%) of preweaned calves that arrived at operations subsequently died before weaning.

Post transport practices for calf raisers that receive calves

The majority (86.2%, 25/29) of calf-raising operations that received transported preweaned calves during 2022 were most frequently identified as calf ranches that raise preweaned calves that originated from a dairy, followed by auction or livestock markets (10.3%, 3/29) and veal operations (3.4%, 1/29). Calf ranches primarily raised calves for subsequent beef production (33.3%, 8/24) or to serve as replacement heifers (25.0%, 6/24). About half (41.7%, 10/24) of operations indicated they raised calves for both purposes. The number of calves on milk varied among operations, with 20.7% having had fewer than 80 head (6/29), 24.1% with 80-200 head (7/29), 17.2% with 200-500 head (5/29), and 31.0% with over 1000 head (9/29). Nearly all operations (92.9%, 26/28) received preweaned calves from multiple dairies. In the past year, the median proportion of calves purchased by the operation and later sold back to the dairy was 58.0% (1st Quartile: 35.0%, 3rd Quartile: 77.5%). Similarly, for calves purchased by the operation but not sold back to the dairy, the median proportion was 50.0% (1st Quartile: 24.0%, 3rd Quartile: 83.5%). The median proportion of calves that operations reported were purchased from auction markets or sale barns was 27.0% (1st Quartile: 10.5%, 3rd Quartile: 50.5%). Additionally, the median proportion of calves that all operations report originated from another owned dairy was 25.0% (1st Quartile: 14.0%, 3rd Quartile: 50.0%).

Over the past year the median percentage of preweaned calves that arrived on calf-raising operations was 40.0% (1st Quartile: 20.0%, 3rd Quartile: 75.0%) Holstein heifers, 40.0% (1st Quartile: 19.0%, 3rd Quartile: 59.0%) beef-on-dairy crosses, and 25.0% (1st Quartile: 11.0%, 3rd Quartile: 60.0%) dairy bull calves. Among the operations that received preweaned calves, 39.3% (11/28) report that the majority (>50%) of their calves were transported from dairies located less than 50 miles from their operation. Additionally, a quarter of the operations reported that

preweaned calves traveled distances of either 51-100 miles (25.0%, 7/28) or 101-500 miles (25.0%, 7/28), and 10.7% (3/28) reported receiving calves from dairies located 501-1000 miles. The approximate age for the majority (>50%) of calves that arrived at operations within the last year varied between ≤24 hrs old (17.9%, 5/28) up to 7-14 days (3.6%, 1/28). Over half of operations reported the approximate age of calves at arrival to be 2 days old (32.1%, 9/28) or 3 days old (21.6%, 6/28).

Most calf-raising operations (93.1%, 27/29) conducted a formal assessment of calves upon arrival to their operation, but only half (55.2%, 16/29) collected blood samples from calves to determine their transfer of passive immunity status. The proportion of operations that reported that preweaned calves arrived with suboptimal conditions after transport are included in Table 18. Calf-raising operations were asked about disease incidence during the entire preweaned period; the median incidence rate for gastrointestinal issues (i.e., diarrhea) was 22.0% (1st Quartile: 9.0%, 3rd Quartile: 50.25%). The median incidence rate for respiratory issues was 20.0% (1st Quartile: 11.0%, 3rd Quartile: 36.0%) and 7.0% (1st Quartile: 2.0%, 3rd Quartile: 10.0%) for navel infection or inflammation. The median incidence rate of calves that died before weaning after arriving at operations was 4.0% (1st Quartile: 2.0%, 3rd Quartile: 7.5%).

The most frequently reported practice that calf-raisers required from their source dairies was colostrum (79.3% (23/29). Less than a fourth of operations required preconditioning practices for preweaned calves transported to their operation. While only 24.1% of calf-raisers required their source operation to provide milk before transport, over half (55.2%, 16/29) identified this as an important preconditioning aspect for calves on milk. Most calf-raisers indicated a willingness to require source farms to implement additional preconditioning practices, with the majority responding yes or maybe (86.0%, 25/29).

Haulers that transport preweaned calves

This survey received responses from 25 haulers, representing approximately 66,200 total calves. The median number of calves less than 1 week of age that haulers reported to have transported from dairies to calf-raising facilities in the last year was 1200 calves (1st Quartile: 1000, 3rd Quartile: 1500). Haulers picked up calves from two (24.1%, 7/25), three (32.0%, 8/25), four (8.0%, 2/25), and more than five operations (28.0%, 7/25). They delivered calves to two (36.0%, 9/25), three (28.0%, 7/25), four (8.0%, 2/25), and more than five operations (20.0%, 5/25). Most haulers (60.0%, 15/25) picked up the majority (>50%) of their calves on milk from a cow/calf operation or a dairy operation (24.0%, 6/25). They delivered the majority (>50%) of their calves on milk to a calf ranch (44.0%, 11/25) or an auction or livestock market (36.0%, 9/25).

Training for employees who handle preweaned calves on dairies and calf-raising operations, and for haulers

The majority (93.3%, 56/60) of operations provided some form of training to employees who handle calves prior to transport. Colostrum feeding (96.4%,53/55), colostrum management (80.0%, 44/55), calf handling (89.1%, 49/55), and newborn care (87.3%, 48/55) were the most frequently reported topics discussed in training programs across operations. Training was most often provided to employees through managers (92.7%, 51/55) and another employee (50.9%, 28/55). Operations also utilized video training (40.0%, 22/55) and training through their herd veterinarian (38.2%, 28/55) and the National Dairy Farmers Assuring Responsible Management (FARM) program (27.3%, 15/55).

Of the dairy operations that transport calves with retained ownership and have employees who handle preweaned calves immediately after transport, the majority (94.4%, 17/18) provided training to those employees. The most prevalent topics discussed in this employee training were calf handling (100%, 16/16) and disease identification (100%, 16/16). Additionally, operations identified newborn care (81.3%, 13/16), record keeping (68.8%, 11/16), and sanitation (81.3%, 13/16) as topics discussed in employee training. All operations (100%, 16/16) provided training to their employees through the manager, and over half (62.5%, 10/16) provided training through another employee. Over half (56.3%, 9/16) of operations utilized their herd veterinarian to provide training, and half (50.0%, 8/16) of operations used video training as a format of training for employees.

The majority (89.7%) of operations that receive calves provided some form of training to employees who handle calves immediately after transport. Common topics that are covered in employee training are calf handling (88.0%, 22/25), disease identification (80.0%, 20/25), newborn care (72.0%, 18/25), and sanitation (68.0%, 17/25). Managers were the primary source in which training was provided to employees (88.5%). Beyond managers, other employees (38.5%, 10/26) and the herd veterinarian (34.6%, 9/26) were utilized as sources to train employees.

The majority (80.0%, 20/25) of haulers had over 2 years of experience in transporting calves on milk. Haulers who received training with specific information on transporting calves on milk (76.0%, 19/25) received training as often as monthly (47.4%, 9/25) or annually (47.4%, 9/25).

Challenges and resources

Dairy operations were asked to identify the top three challenges regarding calf transportation. The most frequently reported challenges identified by operations were economic, including labor costs and availability (33.3%, 19/57) and the low price of calves (29.8%, 17/57). Additionally, issues related to resources for calf care were highlighted, such as space availability in case of delayed calf pick (28.1%, 16/57) and the lack of resources to house calves prior to transport (24.0%, 8/57). Transportation logistics like duration of travel and availability of drivers were a common challenge (21.1%, 12/57). Only 3.5% (2/57) of respondents indicated that finding buyers for calves was a challenge. The resources identified by operations as most helpful in addressing these challenges include best practice recommendations (35.7%, 20/56), more options and markets for selling calves (32.1%, 18/56), and training programs for employees (37.5%, 21/56). The most common resource identified by half of operations was an increased premium or sale price for calves (50%, 28/56).

The most common challenge identified on operations that receive calves was calf health or condition upon arrival (53.6%, 15/28). Distance of calf facility from operation (46.4%, 13/28) was the second most common challenge identified by operations, followed by calf health or condition during the milk feeding phase (39.3%, 11/28).

The top resource identified by operations that receive preweaned calves was increased preconditioning strategies (51.9%, 14/27). Additionally, best practices recommendations (48.1%, 13/27) and increased communication between the dairy and calf ranch by managers and leads (44.4%, 12/27) were common resources identified across operations.

The majority of haulers reported that calf health (60.0%, 15/25) and distance from the calf facility to the dairy (64.0%, 16/25) are challenges they face when transporting calves on milk. Resources that haulers most often identified would be most helpful to address these challenges were best practices recommendations (64.0%, 16/25) and increased communication between the dairy and calf ranch by managers and leads (68.0%, 17/25) followed by a better understanding of driver turnover and/or driver schedule (56.0%, 14/25).

2.4 Discussion

This study aimed to describe the current industry practices regarding the transportation of preweaned dairy and beef-on-dairy calves in the United States, determine differences in pre-transport management between replacement heifer, beef-on-dairy, and dairy bull calves, and identify outreach and research needs to address calf welfare concerns related to transportation.

Over half of the respondents in the present study identified as male as well as identified as owners or managers of their operations. These findings align with demographic trends reported in recent surveys on male calf care practices by Wilson et al. (2023) and Creutzinger et al. (2022), which suggest that male producers are most often involved in calf transport decisions and owners and managers are most often providing that data on calf transport and management practices. Many participants in our study were in the Midwest, likely due to recruitment efforts through the University of Wisconsin-Madison Extension Office. As a result, our findings are most representative of practices within the Midwest region and may not be generalizable to all producers.

Dairy operations

All but one dairy operation reported feeding colostrum to all calves regardless of class, with the exception being an operation that provided colostrum to replacement heifer and beef-on-dairy calves but not to bull calves. Like our findings, previous survey data also saw most operations reported providing colostrum to bull calves (Renaud et al., 2017; Shivley et al., 2019). However, a small percentage of producers report they do not provide colostrum to bull calves, highlighting an area for improvement in management to ensure that bull calves always receive colostrum (Renaud et al., 2017; Shivley et al., 2019). A difference in the timing of the first colostrum feeding after parturition was observed, with replacement heifers receiving colostrum sooner than dairy bull calves. These findings are consistent with previous studies suggesting female replacement calves receive colostrum sooner than their male counterparts (Cheng et al., 2024; Renaud et al., 2020; Shivley et al., 2019). This study also found a difference in the timing of the first colostrum feeding after parturition, with replacement heifers receiving colostrum sooner than beef-on-dairy calves. As interest in beef-on-dairy calves continues to rise from the beef sector, the number of beef-on-dairy calves leaving the dairy annually is expected to grow. Given this increasing calf population, further exploration into management discrepancies is necessary to ensure all calves receive optimal care to be successful regardless of their final destination.

In our study, the majority of operations reported providing a total feeding of ≥4qt colostrum, with no significant differences observed between calf classes. These findings are similar to those by Cheng et al. (2024), in which the majority of operations reported providing equal volumes of colostrum to bull and heifer calves, but contrast with earlier studies that identified a trend of operations providing bull calves with lower total volumes of colostrum

compared to heifer calves (Renaud et al., 2020; Shivley et al., 2019). Given the few differences in practice beyond timing reported between calf classes and the continued prevalence of failed transport of passive immunity in both male and female calves, there remains a need for improved colostrum management across all calf classes, which should be addressed in future outreach and industry initiatives (Wilson et al., 2023; Renaud et al., 2020).

Although the majority of operations conducted formal health evaluations before transporting calves, there was considerable variation in the criteria used to determine a calf's fitness for transport across operations. Evaluating fitness for transport is to ensure that animals can withstand transportation without compromising their welfare (Edwards-Callaway et al., 2019). Most operations indicated that calves showing signs of dehydration, diarrhea, respiratory issues, or lameness would be deemed unfit for transport; however, up to 33%, 30%, 25%, and 20% of dairy operations in our study would still transport calves with dehydration, diarrhea, respiratory issues, or lameness, respectively. Moreover, 5 to 55% of operations indicated they would still transport calves with any suspected illnesses or injuries. Although these operations represented the minority in our study, the cumulative effect is significant, given that even a small proportion of operations allowing the transportation of unfit calves can translate to thousands of calves that are transported under poor health conditions every year. Inconsistent criteria for assessing calf fitness can pose a significant risk to the health of all calves during transport since calves often commingle with animals from different operations, increasing their risk of exposure to pathogens (Hulbert and Moisá, 2016). Transporting compromised calves from the dairy is likely one contributing factor to previous reports of calves arriving at their destinations in suboptimal conditions (Cramer et al., 2024a; Wilson et al., 2020b). Moreover, given that certain health traits such as dehydration, navel inflammation, and low body weight have been linked to future

morbidity and mortality (Renaud et al., 2018; Winder et al., 2016), it is essential to prevent these at-risk calves from leaving the dairy and to limit their entry onto calf raising facilities. Notably, many calf raiser and dairy operations in the present study emphasized the need for clear recommendations on best practices in calf transport, highlighting the industry's demand for structured guidance. Fitness for transport criteria for calves is critical to ensure that only healthy animals are transported. The Calf Care Quality Assurance (CCQA) program outlines fitness for transport recommendations for young calves, developed by a diverse group of experts. These recommendations identify specific conditions that render calves unfit for transport, such as dehydration, poor body condition, lameness or nonambulatory, and active disease cases (CCQA, 2022). Given the challenges of calves being transported in suboptimal conditions (Cramer et al., 2024b), and producers' interest in best practice recommendations, promoting fitness for transport criteria should be a key focus for future outreach and industry initiatives.

While the present study found that most operations provided milk within two hours before transport and half of the operations provided water immediately before transport, previous studies indicated that over half of non-replacement dairy calves were dehydrated before transport and upon arrival at their destination (Cramer et al., 2024a; England et al., 2023; Maggard et al., 2024). Since milk and water provision during transport is uncommon due to logistical challenges, optimal nutrition management at the dairy is essential to prepare calves for success (Creutzinger et al., 2021; Cramer et al., 2024b). Data from calf-raisers suggest that current nutrition management is insufficient in preventing dehydration and hypoglycemia, highlighting the need to address nutrition management at the dairy and throughout the marketing process (England et al., 2023; Maggard et al., 2024).

Across all three calf classes, most operations transported calves at 3 days old or younger, consistent with previous studies that reported calves were transported at an average age of less than 7 days of age (Wilson et al., 2020a; Shivley et al., 2019; Creutzinger et al., 2022; Maggard et al., 2024). Given its influence on calf health and development, transport age has been identified as an important predictor for calf health outcomes following transport (Creutzinger et al., 2021). Most recent studies by Marcato et al. (2020a, b) and Goetz et al. (2023a, b) found that calves transported at older ages had reduced incidences of diarrhea and respiratory disease, a more developed adaptive immune system, and improved growth.

Recognizing the challenges of transporting young calves, many countries have established regulations that focus on minimum age requirements to help address these issues (Council of the European Union, 2004; Animal Health Australia, 2012; New Zealand Government, 2018). However, in the United States, there are no regulations regarding the minimum age for calf transport (United States Code, 1994). Our study identified a potential barrier to keeping calves at the source dairy for a longer period: about one-quarter of dairy operations in this study indicated that space availability for calves in case of delayed pick-up was a concern, emphasizing a current limitation on postponing transport until calves are older. Therefore, operational and logistical factors need to be considered when assessing the potential impacts of delayed transport in the United States.

In this study, no statistical differences were observed between calf class in terms of transportation distance and duration. The median distances and durations reported by dairy operations were shorter in comparison to previous studies (Cramer et al., 2024a; Pempek et al., 2017; Roadknight et al., 2021; Cave et al., 2005). The distance of calf facility from dairies was a common challenge reported by calf-raisers and haulers in the present study, but very few dairies

reported this as a challenge. In our study, the majority of dairy operations transported replacement heifers directly to calf raisers. However, about one-quarter to one-third of operations transported beef-on-dairy and dairy bull calves to auctions, livestock markets, or other private calf sellers, such as calf jockeys or dealers, who act as intermediaries in the calf market. These results are similar to a previous study that found that approximately 30% of non-replacement calves were purchased from a third party (Maggard et al., 2023). Nonreplacement calves are typically sold through a third party and transported through one or more locations, such as an auction or livestock market (USDA, 2016; Creutzinger et al., 2021). This can create further challenges for non-replacement calves who have prolonged exposure to transport stressors such as commingling with animals, various handling techniques, and food and water deprivation (Roadknight et al., 2021; Creutzinger et al., 2021; Cramer et al., 2024b). Therefore, when assessing a calf's fitness for transport, it is crucial to consider not only the initial journey but also the entire marketing process.

Most respondents from dairy operations expressed a willingness to adopt additional preconditioning practices. While navel dipping was widely performed across all calf classes, less than half of the operations in our study reported implementing other preconditioning measures. These findings suggest that while operations recognize the potential benefits of preconditioning, there are current barriers to its implementation. The study identified financial constraints, such as labor costs and the low price of calves, as challenges for dairy operations, which may explain why preconditioning practices are currently limited. For example, focus groups conducted by Creutzinger et al. (2022) identified that producers were generally reluctant to dedicate resources to calves when they received little compensation. Research has shown that a larger proportion of producers believe a price premium for healthier, more vigorous calves would be a stronger

motivator to improve male calf care compared to a disincentive (Wilson et al., 2023). Offering financial incentives, such as premiums per head, could encourage dairy operations to implement additional practices that can improve calf health and welfare (Creutzinger et al., 2022).

As previously mentioned, the majority of respondents identified as owners and managers of their operations. While owners and managers typically have authority over operational decisions and oversight of practices, they may be disconnected from the realities of daily tasks, such as marketing and transportation, which are often carried out by employees or staff members (Durst et al., 2018). As a result, their responses might not fully reflect the actual day-to-day implementation of guidelines, adherence to protocols, or the extent to which employees are aware of and meet operational expectations.

Calf raisers

Calf raisers reported that preweaned calves arriving at their operation traveled varying distances from the source dairy, with over a third of operations reporting calves traveled 100 or more miles. This is a significant contrast from previous literature on off-site heifer rearing, where less than 6% of dairy operations reported transporting calves 100 or more miles (USDA, 2022). There is a lack of comprehensive data on the distance or duration of calf transport in the United States (Creutzinger et al., 2021). This could suggest that calves, or certain calf classes, may travel greater distances than previously recorded to reach calf raisers. Additional data collection on transport practices in the United States is needed to confirm this.

Our study saw very few calf raisers required source dairies to provide preconditioning practices prior to transport. Most calf raisers in our study were identified as calf ranches, making the lack of preconditioning requirements interesting. Calf ranches, who invest time and money

into raising calves, may benefit from greater preconditioning requirements to reduce morbidity, mortality, and production losses. Similar to dairy operations, the majority of calf raisers indicated a willingness to require additional preconditioning practices for calves prior to transport. While both sectors are willing to adopt these practices, a transaction is needed to facilitate implementation, likely in the form of an incentive. However, determining who should provide these incentives remains a significant challenge. Deciding who bears the responsibility and how to justify the associated costs requires further investigation. It may be beneficial to calf ranches to initially absorb higher costs for better care at the dairy farm, as this could translate to improved calf health, reduced medical expenses, and enhanced productivity over time (Creutzinger et al., 2022). Further research is needed to explore effective ways to foster collaboration and establish clear exchanges between sectors to promote improved calf care practices.

Calf health was identified as a major challenge for calf raisers and haulers in our survey, but not for dairy operations. This may be due to the limited feedback dairies receive after calves leave their operations. Previous survey data reported that over half of dairies rarely receive feedback on their calves (Cheng et al., 2024), which suggests that dairies often have limited involvement with calves after they leave, especially non-replacement calves that most likely will not return to the original dairy operation. This communication gap could be preventing dairy operations from fully considering the long-term outcomes of their management practices. Addressing this disconnect by fostering better communication and collaboration between these sectors is essential to improving calf health and enhancing the efficiency and sustainability of the production system.

Haulers

Haulers in our study most often received and delivered calves to multiple operations, including dairies, calf ranches, cow-calf ranches, veal facilities, sale yards, and auctions, highlighting the variability of calf movement across different sectors of the production system. Additionally, haulers reported transporting over a thousand calves at less than a week old in the past year. At less than a week old, these calves may undergo long transport distances and multiple transport events, with exposure to challenges like commingling with unfamiliar animals and prolonged fasting (Creutzinger et al., 2021). These findings emphasize the complexity of calf transport, highlighting the need for management strategies to mitigate stress and health risks associated with transporting young calves.

All operations

When developed and delivered correctly, training has been shown to positively influence animal welfare and worker health and safety (Roman-Muniz et al., 2016; Hagevoort and Roman-Muniz, 2019). Many haulers reported receiving training from quality assurance programs such as beef quality assurance transportation (BQAT) and CCQA. In contrast, dairy and calf-raising operations rarely reported utilizing these programs for employee training, instead relying on managers and other employees for employee training. This presents an opportunity for quality assurance programs to promote more uniform training across dairy and calf-raising operations. Expanding the use of quality assurance programs, especially CCQA, specifically designed for calf care, can help standardize practices by providing uniform training that promotes best practice recommendations for calf care and transportation. Continued outreach and promotion of these quality assurance programs are essential to ensure they reach their intended audience and drive greater adoption across the industry.

Some limitations exist in the present study such as a smaller sample size, bot compromise, and the potential for selection and response bias. First, although steps were taken to increase the sample size such as extending the recruitment deadline and recruiting through various outlets, the response rate remained low. The length of the survey, specifically for dairy and calf raiser operations, may have resulted in response drop-off. While farm lists for dairies can be gathered for many states, this does not exist for calf-raising facilities or haulers. Although a smaller sample size, this is the first study to characterize calf transport practices in the US and valuable insights were obtained. Next, a significant influx of bot responses on two separate occasions resulted in the loss of all survey data collected on those dates, and we were unable to distinguish between genuine and bot submissions on these days. Thus, this may have led to a loss of potentially credible survey responses for those dates. Finally, we utilized organizations such as DCHA, Progressive Dairy, and Hoards Dairyman magazine to help distribute, which may have led to selection bias. We might expect that more progressive producers would be members of these organizations and, therefore, may have more optimal management practices and also be more interested in participating in this research. Specifically, our recruitment through UW-Madison extension outreach likely overrepresented individuals who are already engaged with the extension office and, as a result, may be more receptive to improving practices. Furthermore, our results relied on the self-reporting by those working on operations, and thus responses were susceptible to potential bias. Survey respondents may have incorrectly recalled specific practices for different calf classes (recall bias), or they may have felt compelled by social pressures to report practices that align with positive public perceptions (social desirability bias; Althubaiti, 2016). As Creutzinger et al. (2022) suggest, producers with established, positive relationships with extension offices or veterinarians are often more progressive in their dairy management

approaches. This may have skewed the sample toward individuals more receptive to improving practices, potentially limiting the generalizability of our findings.

2.5 Conclusion

The present study offers descriptive and comparative insights into current transportation management practices for replacement heifer, beef-on-dairy, and dairy bull calves across dairy operations, calf haulers, and calf raisers in the United States. Dairy operations reported a difference in age at transport between each calf class. Furthermore, a greater proportion of dairy operations were found to have provided colostrum to replacement heifers sooner after birth compared to beef-on-dairy and dairy bull calves. Some preconditioning practices differed between replacement heifer and beef-on-dairy calves and between beef-on-dairy and dairy bull calves. More than a third of calf raisers reported that preweaned calves arriving at their operation traveled 100 or more miles.

To the authors' knowledge, this study is one of the first to compare pre-transport management practices between replacement heifer, beef-on-dairy, and dairy bull calves. The findings indicate that additional work is needed to ensure uniform care across calf classes, especially in colostrum practices. Feedback from different stakeholders highlighted the need for best practice recommendations and increased communication between sectors and areas for collaboration between dairies and calf raisers. These insights can help guide future improvements in calf transport and management strategies to support calf health and welfare and industry sustainability.

TABLES

Table 1. Number and percentage (n, %) of all dairy operations that reported transporting the majority of calves in each age category in 2022, by calf class

Age	Replacement heifer (n = 40) (*n*, %)	Beef-on-dairy (n = 57) (*n*, %)	Dairy bull (n = 56) (*n*, %)
< 24hrs	9, 22.5	11, 19.3	11, 19.6
1 day	4, 10	9, 15.8	8, 14.3
2 days	7, 17.5	10, 17.5	9, 16.1
3 days	5, 12.5	10, 17.5	8, 14.3
≥ 4 days[1]	15, 37.5	17, 29.8	20, 35.7

[1]Combined categories "4-7 days," "7-14 days," and "≥14 days but before weaning."

Table 2. Pairwise comparisons[1] of calf age at transport on dairy operations (n, %) that reported transporting both replacement heifer and beef-on-dairy calves in 2022[2] (P < 0.0001)

Age	Replacement heifer (n = 36)	Beef-on-dairy (n = 36)
< 24hrs	9, 25	11, 30.6
1 day	4, 11.1	6, 16.7
2 days	6, 16.7	6, 16.7
3 days	5, 13.9	7, 19.4
≥ 4 days[3]	12, 33.3	6, 16.7

[1]A Bhapkar test was performed between each calf class.

[2]Only dairy operations (n=36) that transported both replacement heifers and beef-on-dairy calves in 2022 were included in this pairwise analysis. Respondents were asked about the age at transport for the majority of calves.

[3]Combined categories "4-7 days," "7-14 days," and "≥14 days but before weaning."

Table 3. Pairwise comparisons[1] of calf age at transport on dairy operations (n, %) that reported transporting both replacement heifer and dairy bull calves in 2022[2] (P < 0.0001)

Age	Replacement heifer (n = 31)	Dairy bull (n = 31)
< 24hrs	8, 25.8	10, 32.3
1 day	4, 12.9	6, 19.4
2 days	6, 19.4	4, 12.9
3 days	4, 12.9	4, 12.9
≥ 4 days[3]	9, 29	7, 22.6

[1]A Bhapkar test was performed between each calf class.

[2]Only dairy operations (n=31) that transported both replacement heifer and dairy bull calves in 2022 were included in this pairwise analysis. Respondents were asked about the age at transport for the majority of calves.

[3]Combined categories "4-7 days," "7-14 days," and "≥14 days but before weaning."

Table 4. Pairwise comparisons[1] of calf age at transport on dairy operations (n, %) that reported transporting both beef-on-dairy and dairy bull calves in 2022[2] (P = 0.009)

Age	Beef-on-dairy (n = 48)	Dairy bull (n = 48)
< 24hrs	9, 18.8	10, 20.8
1 day	8, 16.7	7, 14.6
2 days	8, 16.7	6, 12.5
3 days	8, 16.7	8, 16.7
≥ 4 days[3]	15, 31.3	17, 35.4

[1]A Bhapkar test was performed between each calf class.

[2]Only dairy operations (n=49) that transported both beef-on-dairy and dairy bull calves in 2022 were included in this pairwise analysis. One operation did not respond for beef-on-dairy or dairy bull calves, therefore was excluded from analysis. Respondents were asked about the age at transport for the majority of calves.

[3]Combined categories "4-7 days," "7-14 days," and "≥14 days but before weaning."

Table 5. Timing of the first colostrum feeding in 2022 for the majority of calves prior to transport reported by all dairy operations (n, %), by calf class

All operations			
Time	**Replacement heifer (n = 40)**	**Beef-on-dairy (n = 58)**	**Dairy bull (n = 56)**
< 1 hour	18, 45	20, 34.5	24, 42.9
1-2 hours	17, 42.5	27, 46.6	19, 33.9
≥ 3 hours	5, 12.5	11, 19.0	13, 23.2

Table 6. Pairwise comparisons[1] of first colostrum feeding timing on dairy operations (n, %) that reported transporting both replacement heifers and beef-on-dairy calves in 2022[2] (P = 0.022)

Time	**Replacement heifer (n = 36)**	**Beef-on-dairy (n = 36)**
< 1 hour	16, 44.4	13, 36.1
1-2 hours	15, 41.7	17, 47.2
≥ 3 hours	5, 13.9	6, 16.7

[1]A Bhapkar test was performed between each calf class

[2]Only dairy (n=36) operations that transported both replacement heifer and beef-on-dairy calves in 2022 were included in this pairwise analysis. Respondents were asked how soon after birth colostrum was provided to the majority of calves.

Table 7. Pairwise comparisons[1] of first colostrum feeding timing on dairy operations (n, %) that reported transporting both replacement heifers and dairy bull calves in 2022[2] (P = 0.024).

Time	Replacement heifer (n = 30)	Dairy bull (n = 30)
< 1 hour	13, 43.3	14, 46.7
1-2 hours	12, 40	9, 30
≥ 3 hours	5, 16.7	7, 23.3

[1]A Bhapkar test was performed between each calf class

[2]Only dairy operations (n=31) that transported both replacement heifer and dairy bull calves in 2022 were included in this pairwise analysis. One operation did not provide colostrum to their dairy bull calves and did not receive colostrum management questions, therefore was excluded from analysis. Respondents were asked how soon after birth colostrum was provided to the majority of calves.

Table 8. Pairwise comparisons[1] of first colostrum feeding timing on dairy operations (n, %) that reported transporting both beef-on-dairy and dairy bull calves in 2022[2] (P = 0.2)

Time	Beef-on-dairy (n = 48)	Dairy bull (n = 48)
< 1 hour	17, 35.4	19, 39.6
1-2 hours	20, 41.7	16, 33.3
≥ 3 hours	11, 22.9	13, 27.1

[1]A Bhapkar test was performed between each calf class.

[2]Only dairy operations (n=49) that transported both beef-on-dairy and dairy bull calves in 2022 were included in this pairwise analysis. One operation did not provide colostrum to their dairy bull calves and did not receive colostrum management questions, therefore was excluded from analysis. Respondents were asked how soon after birth colostrum was provided to the majority of calves.

Table 9. Number and percentage (n, %) of all dairy operations that included each practice in their preconditioning program for calves prior to transport in 2022, by calf class

All operations			
Practices	**Replacement heifer (n = 38)**	**Beef-on-dairy (n = 55)**	**Dairy bull (n = 54)**
Antibiotics	8, 21.1	5, 9.1	6, 11.1
Electrolytes	11, 28.9	33, 60.0	12, 22.2
Navel dipping	33, 86.8	50, 90.9	48, 88.9
Supplements	10, 26.3	14, 25.5	15, 27.8
NSAIDs	5, 13.2	4, 7.3	4, 7.4
Vaccines	23, 60.5	19, 34.5	13, 24.1
Nothing	3, 7.9	7, 12.7	6, 11.1

Table 10. Pairwise comparisons[1] of preconditioning practices for calves prior to transport on dairy operations (n, %) that reported transporting both replacement heifer and beef-on-dairy calves in 2022[2]

Practices	**Replacement heifer (n = 33)**	**Beef-on-dairy (n = 33)**	**p-value**
Antibiotics	7, 21.2	5, 15.2	1
Electrolytes	10, 30.3	8, 24.2	1
Navel dipping	32, 97	30, 90.9	1
Supplements	9, 27.3	5, 15.2	0.4
NSAIDs	5, 15.2	3, 9.1	1
Vaccines	21, 63.6	13, 39.4	0.03
Nothing	3, 9.1	7, 21.2	0.7

[1]A McNemar test was performed between each calf class for each practice.

[2]Only dairy operations (n=36) that transported both replacement heifer and beef-on-dairy calves in 2022 were included in this pairwise analysis. Three operations did not provide a response for either replacement heifer or beef-on-dairy calves, therefore were excluded from analysis. Respondents were asked about the practices currently performed for calves prior to transport.

Table 11. Pairwise comparisons[1] of preconditioning practices for calves prior to transport on dairy operations (n, %) that reported transporting both replacement heifer and dairy bull calves in 2022[2]

Practices	Replacement heifer (n = 29)	Dairy bull (n = 29)	p-value
Antibiotics	7, 24.1	4, 13.8	0.7
Electrolytes	8, 27.6	8, 27.6	1
Navel dipping	27, 93.1	25, 86.2	1
Supplements	8, 27.6	6, 20.7	1
NSAIDs	5, 17.2	3, 10.3	1
Vaccines	16, 55.2	7, 24.1	0.02
Nothing	1, 3.4	4, 13.8	0.7

[1]A McNemar test was performed between each calf class for each practice.

[2]Only dairy operations (n=31) that transported both replacement heifer and dairy bull calves in 2022 were included in this pairwise analysis. Two operations did not provide responses for either replacement heifer or dairy bull calves, therefore were excluded from analysis. Respondents were asked about the practices currently performed for calves prior to transport.

Table 12. Pairwise comparisons[1] of preconditioning practices for calves prior to transport on dairy operations (n, %) that reported transporting both beef-on-dairy and dairy bull calves in 2022[2]

Practices	**Beef-on-dairy (n = 46)**	**Dairy bull (n = 46)**	**p-value**
Antibiotics	4, 8.7	5, 10.9	1
Electrolytes	10, 21.7	11, 23.9	1
Navel dipping	42, 91.3	42, 91.3	1
Supplements	12, 26.1	13, 28.3	1
NSAIDs	4, 8.7	4, 8.7	1
Vaccines	16, 34.8	13, 28.3	0.4
Nothing	5, 10.9	3, 6.5	0.7

[1]A McNemar test was performed between each calf class for each practice.

[2]Only dairy operations (n=49) that transported both beef-on-dairy and dairy bull calves in 2022 were included in this pairwise analysis. Three operations did not provide a response for either replacement heifer or beef-on-dairy calves, therefore were excluded from analysis. Respondents were asked about the practices currently performed for calves prior to transport.

Table 13. Number and percentage of all dairy operations (n, %) that indicated they would not transport a calf with each condition in 2022, by calf class[1]

Condition	Replacement heifer (n = 40)	Beef-on-dairy (n = 56)	Dairy bull (n = 55)
Bone fractures	36, 90	53, 94.6	51, 92.7
Coat is still wet	34, 85	46, 82.1	47, 85.5
Dehydration	29, 72.5	43, 76.8	37, 67.3
Diarrhea/scours	28, 70	45, 80.4	44, 80
Difficulty breathing	32, 80	46, 82.1	45, 81.8
Extremely thin	23, 57.5	35, 62.5	33, 60
Has not received minimum feedings	27, 67.5	39, 69.6	35, 63.6
Navel inflammation	18, 45	35, 62.5	37, 67.3
No ID	30, 75	24, 42.9	22, 40
Premature	18, 45	36, 64.3	33, 60
Respiratory disease	30, 75	44, 78.6	42, 76.4
Severe lameness	32, 80	49, 87.5	47, 85.5
Unable to stand unassisted	31, 77.5	48, 85.7	46, 83.6
Unable to walk unassisted	27, 67.5	47	44, 80

[1]Respondents were asked what conditions would deem a calf unfit for transport.

Table 14. Pairwise comparisons[1] of dairy operations (n,%) that indicated they would not transport a calf with each trait on operations that transported both replacement heifers and beef-on-dairy calves in 2022[2].

Replacement heifer vs beef-on-dairy			
Condition	**Replacement heifer (n = 35)**	**Beef-on-dairy (n = 35)**	**p-value**
Bone fractures	32, 91.4	33, 94.3	1
Coat is still wet	32, 91.4	28, 80	0.4
Dehydration	27, 77.1	25, 71.4	0.7
Diarrhea/scours	24, 68.6	25, 71.4	1
Difficulty breathing	27, 77.1	26, 74.3	1
Extremely thin	21, 60	20, 57.1	1
Has not received minimum feedings	25, 71.4	25, 71.4	1
Navel inflammation	15, 42.9	16, 45.7	1
No ID	27, 77.1	18, 51.4	0.02
Premature	18, 51.4	20, 57.1	1
Respiratory disease	26, 74.3	25, 71.4	1
Severe lameness	27, 77.1	29, 82.9	1
Unable to stand unassisted	26, 74.3	28, 80	1
Unable to walk unassisted	23, 65.7	27, 77.1	0.4

[1]A McNemar test was performed between each calf class for each practice.

[2]Only dairy operations (n=36) that transported both replacement heifer and beef-on-dairy calves in 2022 were included in this pairwise analysis. One operation did not provide a response for either replacement heifer or beef-on-dairy calves, therefore were excluded from analysis. Respondents were asked what conditions would deem a calf unfit for transport.

Table 15. Pairwise comparisons[1] of dairy operations (n, %) that indicated they would not transport a calf with each condition on operations that reported transporting both replacement heifer and dairy bull calves in 2022[2]

Condition	Replacement heifer (n = 30)	Dairy bull (n = 30)	p-value
Bone fractures	27, 90	28, 93.3	1
Coat is still wet	27, 90	25, 83.3	1
Dehydration	21, 70	17, 56.7	0.4
Diarrhea/scours	20, 66.7	20, 66.7	1
Difficulty breathing	22, 73.3	22, 73.3	1
Extremely thin	16, 53.3	16, 53.3	1
Has not received minimum feedings	21, 70	20, 66.7	1
Navel inflammation	14, 46.7	16, 53.3	1
No ID	22, 73.3	15, 50	0.09
Premature	13, 43.3	11, 36.7	1
Respiratory disease	21, 70	19, 63.3	1
Severe lameness	22, 73.3	23, 76.7	1
Unable to stand unassisted	21, 70	23, 76.7	1
Unable to walk unassisted	18, 60	21, 70	0.5

[1]A McNemar test was performed between each calf class for each practice.

[2]Only dairy operations (n=31) that transported both replacement heifer and dairy bull calves in 2022 were included in this pairwise analysis. One operation did not provide a response for either replacement heifer or dairy bull calves, therefore was excluded from analysis. Respondents were asked what conditions would deem a calf unfit for transport.

Table 16. Pairwise comparisons[1] of dairy operations (n, %) that indicated they would not transport a calf with each condition on operations that transported both beef-on-dairy and dairy bull calves in 2022[2]

Condition	Beef-on-dairy (n = 47)	Dairy bull (n = 47)	p-value
Bone fractures	44, 93.6	44, 93.6	NaN
Coat is still wet	40, 85.1	41, 93.2	1
Dehydration	35, 74.5	32, 68.1	0.5
Diarrhea/scours	37, 78.7	37, 78.7	1
Difficulty breathing	38, 80.9	38, 80.9	1
Extremely thin	27, 57.4	28, 59.6	1
Has not received minimum feedings	33, 70.2	31, 66.0	1
Navel inflammation	29, 61.7	31, 66.0	1
No ID	20, 42.6	20, 42.6	1
Premature	28, 59.6	27, 57.4	1
Respiratory disease	36, 76.6	35, 74.5	1
Severe lameness	40, 85.1	39, 83.0	1
Unable to stand unassisted	39, 83.0	39, 83.0	NaN
Unable to walk unassisted	38, 80.9	37, 78.7	1

[1]A McNemar test was performed between each calf class for each practice.

[2]Only dairy operations that transported both beef-on-dairy and dairy bull calves in 2022 were included in this pairwise analysis. Two operations did not provide a response for either beef-on-dairy or dairy bull calves, therefore were excluded from analysis. Respondents were asked what conditions would deem a calf unfit for transport.

Table 17. Number and percentage of dairy operations (n = 13) that transported and raised preweaned calves at a different location, but with retained ownership, that reported preweaned calves arrived with the following conditions after transport in 2022

Condition	***n*, %**
Bone fractures	5, 38.5
Dehydration	7, 53.8
Diarrhea/scours	10, 76.9
Difficulty breathing/labored breathing	9, 69.2
Extremely thin (BCS below 2)	0, 0
Failed transfer of passive immunity (i.e. low total proteins)	5, 38.5
Navel inflammation/infection	6, 46.2
Non-ambulatory	5, 38.5
Respiratory disease/pneumonia	4, 30.8
Severe lameness/lame on one or more limbs	2, 15.4

Table 18. Number and percentage of operations that received calves (n = 27) that reported preweaned calves arrived with the following conditions after transport in 2022

Condition	***n*, %**
Bone fractures	8, 29.6
Dehydration	16, 59.3
Diarrhea/scours	20, 74.1
Difficulty breathing/labored breathing	14, 51.9
Extremely thin (BCS below 2)	5, 18.5
Failed transfer of passive immunity (i.e. low total proteins)	13, 48.1
Navel inflammation/infection	18, 66.7
Non-ambulatory	6, 22.2
Respiratory disease/pneumonia	12, 44.4
Severe lameness/lame on one or more limbs	8, 29.6

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APPENDIX

Survey of Current Dairy Industry Practices for Preweaned Calf Transportation Dairies/Raisers

Colorado State University is conducting a research survey to describe current industry practices regarding the transportation of dairy or dairy x beef calves on milk in the **United States**. We want to hear from anyone making decisions about the transportation and/or receiving of dairy or dairy x beef calves on milk. That includes producers, owners, operators, or managers on dairies, calf ranches, heifer-raising facilities, and veal operations, as well as transportation drivers. Participants in the research must be over 18 years of age.

Thank you for taking the time to fill out this research survey. For each question that has a fill-in option, you are welcome to add your own selection if you feel it is not best described by one of the choices. The open-ended questions are intended for you to share your personal opinions or experiences. We anticipate the survey should take 15-20 minutes to complete.

Your responses are completely anonymous and will not be used for any purpose other than for our research. There are minimal risks to participating in this survey and you may choose to stop at any time. All responses will be summarized and reported at the aggregate level.

Thank you for taking this survey. If you have any questions about this research project, please contact:

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If you have questions about your rights or welfare as a participant, please contact the CSU Institutional Review Board, at (970) 491-1553 or by email at CSU_IRB@mail.colostate.edu.

CONSENT TO PARTICIPATE QUESTION

- ☐ Yes, I agree that I am over 18 years of age and consent to participate in this study
- ☐ No, I do not consent to participate in this study

The main goals of this study are to better understand current industry practices for transporting calves on milk and if these practices differ between replacement heifers, dairy x beef, and dairy bull calves. We want to understand producers' challenges and needs in this area to identify research and outreach efforts.
For each question, circle your selected answer(s) or fill in the requested information.

This section of the survey asks about replacement heifer calves on milk (heifers that are intended for dairy cow replacements) that are transported off site. Other sections will ask about dairy x beef and dairy bull calves.

Q1. In the last year, approximately how many total **REPLACEMENT HEIFER** calves on milk were transported off the operation prior to weaning? Please only use numbers and do not provide ranges.

_____

If you answer 0 to Q1., please proceed to Q16.

Q2. For these **REPLACEMENT HEIFER** calves on milk that were transported off your operation prior to weaning, will these animals eventually return to your operation? (Select one.)

- ☐ Yes
- ☐ No
- ☐ Other, please specify: _____

Q3. Was colostrum provided to newborn **REPLACEMENT HEIFER** calves prior to transportation? (Select one.)

- ☐ Yes
- ☐ No
- ☐ Other, please specify: _____

If you selected No for Q3., please proceed to Q4.

If you selected Yes or Other for Q3., please answer Q3.1 through Q3.4

Q3.1. How soon after birth was the FIRST colostrum feeding provided to the majority (>50%) of newborn **REPLACEMENT HEIFER** calves? (Select one.)

- ☐ < 1 hour
- ☐ 1-2 hours
- ☐ 3-4 hours
- ☐ 4-5 hours
- ☐ ≥ 6 hours

Q3.2 Which of the following best describes the colostrum quality fed to the majority (>50%) of newborn **REPLACEMENT HEIFER** calves at their FIRST feeding? (Select one.)

- ☐ BRIX reading ≥ 22 (IgG ≥ 50 g/L)
- ☐ BRIX reading < 22 (IgG < 50 g/L)
- ☐ BRIX or IgG is unknown

Q3.3 On average, how much TOTAL colostrum (all feedings) was fed to newborn **REPLACEMENT HEIFER** prior to transportation? (Select one.)

- ☐ 1quart (1L)
- ☐ 2quarts (2L)
- ☐ 3quarts (3L)
- ☐ ≥ 4quarts (1 gallon or 4L)

Q3.4 What system do you use, if any, to ensure a newborn **REPLACEMENT HEIFER** calf has received enough colostrum and can be transported off your facility? (Select all that apply.)

- ○ Chalk or paint marks on the calf
- ○ Paper records
- ○ Dairy employees communicate with driver
- ○ Serum IgG levels
- ○ We currently do not have a system
- ○ Other, please specify: _____

Q4. Which, if any, of the following would influence your decision to improve your colostrum practices for newborn **REPLACEMENT HEIFER** calves prior to transportation? (Select all that apply.)

- ○ Employee training

- ○ Premium paid by the buyer ($/head)
- ○ To avoid penalty by buyer
- ○ To improve calf health
- ○ To meet a third-party audit standard
- ○ To meet calf raiser standards
- ○ To meet buyer standards
- ○ Other, please specify: _____
- ○ I will not improve my colostrum practices
- ○ I already have excellent colostrum program for replacement heifer calves

Q5. For **REPLACEMENT HEIFER** calves on milk ≥12 hours of age at the time of transportation, do you provide a milk feeding within 2 hours prior to being transported? (Select one.)

- ☐ Yes
- ☐ No
- ☐ Other, please specify: _____

Q6. For **REPLACEMENT HEIFER** calves on milk ≥12 hours of age at the time of transportation, did calves have access to water immediately prior to being transported? (Select one.)

- ☐ Yes
- ☐ No
- ☐ Other, please specify: _____

Q7. Within the last year, at what age were the majority (>50%) of **REPLACEMENT HEIFER** calves on milk transported off-site? (Select one.)

- ☐ Less than 24hrs
- ☐ 1 day
- ☐ 2 days
- ☐ 3 days
- ☐ 4-7 days
- ☐ 7-14 days
- ☐ >14 days, but before weaning

Q8. Within the last year, where were the majority (>50%) of **REPLACEMENT HEIFER** calves transported after leaving your facility? (Select one.)

- ☐ Auction or livestock market
- ☐ Calf dealer/jockey
- ☐ Calf ranch or heifer raiser
- ☐ Veal facility
- ☐ Culled or euthanized before transportation
- ☐ Other, please specify: _____

Q9. For the destination selected above, how many MILES on average were **REPLACEMENT HEIFER** calves transported? (Select one.)

- ☐ _____ miles
- ☐ I do not know

Q10. For the destination selected above, how many HOURS on average were **REPLACEMENT HEIFER** calves transported? (Select one.)

- ☐ _____ hours
- ☐ I do not know

Q11. Do you conduct a formal assessment of **REPLACEMENT HEIFER** calf health prior to transportation? (Select one.)

- ☐ Yes
- ☐ No

Q12. Which of the following would deem a **REPLACEMENT HEIFER** calf on milk **unfit** for transportation? (Select all that apply.)

- ○ Bone fractures
- ○ Coat is still wet
- ○ Dehydration
- ○ Diarrhea/scours
- ○ Difficulty breathing
- ○ Extremely thin (BCS <2)
- ○ Has not received minimum colostrum feedings
- ○ Navel inflammation/infection
- ○ No ID tag
- ○ Premature birth (small size, fine hair coat)

- ○ Respiratory disease/pneumonia
- ○ Severe lameness/lame on one or more limbs
- ○ Unable to stand unassisted
- ○ Unable to walk unassisted
- ○ Other, please specify: _____

This portion of the survey asks about "preconditioning", which refers to management practices that are intended to help calves succeed during their next phase of production, such as during transportation, and after at calf-raising facilities, etc.

Q13. Which of the following are included in your preconditioning programs for **REPLACEMENT HEIFER** calves on milk prior to transportation (other than colostrum, milk, water)? (Select all that apply.)

- ○ Antibiotics
- ○ Electrolytes
- ○ Navel dipping
- ○ Non-steroidal anti-inflammatory drugs
- ○ Supplements (i.e. prebiotics, probiotics, etc.)
- ○ Vaccinations
- ○ Other, please specify: _____
- ○ Nothing (other than colostrum, water, and milk) is provided

Q14. Would you be willing to implement additional preconditioning practices (e.g. antibiotics, electrolytes, non-steroidal anti-inflammatory drugs, supplements, vaccinations, etc.) for **REPLACEMENT HEIFER** calves on milk prior to transport? (Select one.)

- ☐ Yes
- ☐ Maybe
- ☐ No

If you answered No to Q14., please proceed to Q16.

If you answered Yes or Maybe to Q14., please answer Q15.

Q15. What would the minimum premium or incentive ($ per head) need to be for you to implement additional preconditioning practices (e.g., antibiotics, electrolytes, non-steroidal anti-inflammatory drugs, supplements, vaccinations, etc.) for **REPLACEMENT HEIFER** calves on milk prior to transport? Please specify $/head

_____$/head

This section of the survey asks about DAIRY x BEEF calves on milk that are transported off of your operation. A subsequent section will ask about dairy bull calves.

Q16. In the last year, approximately how many total **DAIRY x BEEF** calves on milk were transported off of your operation prior to weaning? Please only use numbers and do not provide ranges.

_____

If you answer 0 to Q16., please proceed to Q30.

Q17. Was colostrum provided to newborn **DAIRY x BEEF** calves prior to transportation? (Select one.)

- ☐ Yes
- ☐ No

If you selected No for Q17., please proceed to Q18.

If you selected Yes or Other for Q17., please answer Q17.1 through Q17.4

Q17.1 How soon after birth was the first colostrum feeding provided to the majority (>50%) of newborn **DAIRY x BEEF** calves? (Select one.)

- ☐ < 1 hour
- ☐ 1-2 hours
- ☐ 3-4 hours
- ☐ 4-5 hours
- ☐ ≥ 6 hours

Q17.2 Which of the following best describes the colostrum quality fed to the majority (>50%) of newborn **DAIRY x BEEF** calves at their FIRST feeding? (Select one.)

- ☐ BRIX reading ≥ 22 (IgG ≥ 50 g/L)
- ☐ BRIX reading < 22 (IgG < 50 g/L)
- ☐ BRIX or IgG is unknown

Q17.3 On average, how much TOTAL colostrum (all feedings) was fed to newborn **DAIRY x BEEF** prior to transportation? (Select one.)

- ☐ 1quart (1L)
- ☐ 2quarts (2L)
- ☐ 3quarts (3L)
- ☐ ≥ 4quarts (1 gallon or 4L)

Q17.4 What system do you use, if any, to ensure a newborn **DAIRY x BEEF** calf has received enough colostrum and can be transported off your facility? (Select all that apply.)

- ○ Chalk or paint marks on the calf
- ○ Paper records
- ○ Dairy employees communicate with driver
- ○ Serum IgG levels
- ○ We currently do not have a system
- ○ Other, please specify: _____

Q18. Which, if any, of the following would influence your decision to improve your colostrum practices for newborn **DAIRY x BEEF** calves prior to transportation? (Select all that apply.)

- ○ Employee training
- ○ Premium paid by the buyer ($/head)
- ○ To avoid penalty by buyer
- ○ To improve calf health
- ○ To meet a third-party audit standard
- ○ To meet calf raiser standards
- ○ To meet buyer standards
- ○ Other, please specify: _____
- ○ I will not improve my colostrum practices
- ○ I already have excellent colostrum program for replacement heifer calves

Q19. For **DAIRY x BEEF** calves on milk ≥12 hours of age at the time of transportation, do you provide a milk feeding within 2 hours prior to being transported? (Select one.)

- ☐ Yes
- ☐ No
- ☐ Other, please specify: _____

Q20. For **DAIRY x BEEF** calves on milk ≥12 hours of age at the time of transportation, did calves have access to water immediately prior to being transported? (Select one.)

- ☐ Yes
- ☐ No
- ☐ Other, please specify: _____

Q21. Within the last year, at what age were the majority (>50%) of **DAIRY x BEEF** calves on milk transported off-site? (Select one.)

- ☐ Less than 24hrs
- ☐ 1 day
- ☐ 2 days
- ☐ 3 days
- ☐ 4-7 days
- ☐ 7-14 days
- ☐ >14 days, but before weaning

Q22. Within the last year, where were the majority (>50%) of **DAIRY x BEEF** calves transported after leaving your facility? (Select one.)

- ☐ Auction or livestock market
- ☐ Calf dealer/jockey
- ☐ Calf ranch or heifer raiser
- ☐ Veal facility
- ☐ Culled or euthanized before transportation
- ☐ Other, please specify: _____

Q23. For the destination selected above, how many MILES on average were **DAIRY x BEEF** calves transported? (Select one.)

- ☐ _____ miles
- ☐ I do not know

Q24. For the destination selected above, how many HOURS on average were **DAIRY x BEEF** calves transported? (Select one.)

- ☐ _____ hours
- ☐ I do not know

Q25. Do you conduct a formal assessment of **DAIRY x BEEF** calf health prior to transportation? (Select one.)

- ☐ Yes
- ☐ No

Q26. Which of the following would deem a **DAIRY x BEEF** calf on milk **unfit** for transportation? (Select all that apply.)

- ○ Bone fractures
- ○ Coat is still wet
- ○ Dehydration
- ○ Diarrhea/scours
- ○ Difficulty breathing
- ○ Extremely thin (BCS <2)
- ○ Has not received minimum colostrum feedings
- ○ Navel inflammation/infection
- ○ No ID tag
- ○ Premature birth (small size, fine hair coat)
- ○ Respiratory disease/pneumonia
- ○ Severe lameness/lame on one or more limbs
- ○ Unable to stand unassisted
- ○ Unable to walk unassisted
- ○ Other, please specify: _____

This portion of the survey asks about "preconditioning", which refers to management practices that are intended to help calves succeed during their next phase of production, such as during transportation, and after at calf-raising facilities, etc.

Q27. Which of the following are included in your preconditioning programs for **DAIRY x BEEF** calves on milk prior to transportation (other than colostrum, milk, water)? (Select all that apply.)

- ○ Antibiotics
- ○ Electrolytes
- ○ Navel dipping
- ○ Non-steroidal anti-inflammatory drugs
- ○ Supplements (i.e. prebiotics, probiotics, etc.)
- ○ Vaccinations
- ○ Other, please specify: _____

Q28. Would you be willing to implement additional preconditioning practices (e.g. antibiotics, electrolytes, non-steroidal anti-inflammatory drugs, supplements, vaccinations, etc.) for **DAIRY x BEEF** calves on milk prior to transport? (Select one.)

- ☐ Yes
- ☐ Maybe
- ☐ No

If you answered No to Q28., please proceed to Q30.

If you answered Yes or Maybe to Q28, please answer Q29.

Q29. What would the minimum premium or incentive ($ per head) need to be for you to implement additional preconditioning practices (e.g., antibiotics, electrolytes, non-steroidal anti-inflammatory drugs, supplements, vaccinations, etc.) for **DAIRY x BEEF** calves on milk prior to transport? Please specify $/head

_____ $/head

This section of the survey asks about DAIRY BULL calves on milk that are transported off of your operation.

Q30. In the last year, approximately how many total **DAIRY BULL** calves on milk were transported off of your operation prior to weaning? Please only use numbers and do not provide ranges.

_____

If you answer 0 to Q30., please proceed to Q44.

Q31. Was colostrum provided to newborn **DAIRY BULL** calves prior to transportation? (Select one.)

- ☐ Yes
- ☐ No

If you selected No for Q31., please proceed to Q32.

If you selected Yes or Other for Q31., please answer Q31.1 through Q31.4

Q31.1 How soon after birth was the first colostrum feeding provided to the majority (>50%) of newborn **DAIRY BULL** calves? (Select one.)

- ☐ < 1 hour
- ☐ 1-2 hours
- ☐ 3-4 hours
- ☐ 4-5 hours
- ☐ ≥ 6 hours

Q31.2 Which of the following best describes the colostrum quality fed to the majority (>50%) of newborn **DAIRY BULL** calves at their FIRST feeding? (Select one.)

- ☐ BRIX reading ≥ 22 (IgG ≥ 50 g/L)
- ☐ BRIX reading < 22 (IgG < 50 g/L)
- ☐ BRIX or IgG is unknown

Q31.3 On average, how much TOTAL colostrum (all feedings) was fed to newborn **DAIRY BULL** prior to transportation? (Select one.)

- ☐ 1quart (1L)
- ☐ 2quarts (2L)
- ☐ 3quarts (3L)
- ☐ ≥ 4quarts (1 gallon or 4L)

Q31.4 What system do you use, if any, to ensure a newborn **DAIRY BULL** calf has received enough colostrum and can be transported off your facility? (Select all that apply.)

- ○ Chalk or paint marks on the calf
- ○ Paper records
- ○ Dairy employees communicate with driver
- ○ Serum IgG levels
- ○ We currently do not have a system
- ○ Other, please specify: _____

Q32. Which, if any, of the following would influence your decision to improve your colostrum practices for newborn **DAIRY BULL** calves prior to transportation? (Select all that apply.)

- ○ Employee training
- ○ Premium paid by the buyer ($/head)
- ○ To avoid penalty by buyer
- ○ To improve calf health
- ○ To meet a third-party audit standard
- ○ To meet calf raiser standards
- ○ To meet buyer standards
- ○ Other, please specify: _____
- ○ I will not improve my colostrum practices
- ○ I already have excellent colostrum program for replacement heifer calves

Q33. For **DAIRY BULL** calves on milk ≥12 hours of age at the time of transportation, do you provide a milk feeding within 2 hours prior to being transported? (Select one.)

- ☐ Yes
- ☐ No
- ☐ Other, please specify: _____

Q34. For **DAIRY BULL** calves on milk ≥12 hours of age at the time of transportation, did calves have access to water immediately prior to being transported? (Select one.)

- ☐ Yes
- ☐ No
- ☐ Other, please specify: _____

Q35. Within the last year, at what age were the majority (>50%) of **DAIRY BULL** calves on milk transported off-site? (Select one.)

- ☐ Less than 24hrs
- ☐ 1 day
- ☐ 2 days
- ☐ 3 days
- ☐ 4-7 days
- ☐ 7-14 days
- ☐ >14 days, but before weaning

Q36. Within the last year, where were the majority (>50%) of **DAIRY BULL** calves transported after leaving your facility? (Select one.)

- ☐ Auction or livestock market
- ☐ Calf dealer/jockey
- ☐ Calf ranch or heifer raiser
- ☐ Veal facility
- ☐ Culled or euthanized before transportation
- ☐ Other, please specify: _____

Q37. For the destination selected above, how many MILES on average were **DAIRY BULL** calves transported? (Select one.)

- ☐ _____ miles
- ☐ I do not know

Q38. For the destination selected above, how many HOURS on average were **DAIRY BULL** calves transported? (Select one.)

- ☐ _____ hours
- ☐ I do not know

Q39. Do you conduct a formal assessment of **DAIRY BULL** calf health prior to transportation?

- ☐ Yes
- ☐ No

Q40. Which of the following would deem a **DAIRY BULL** calf on milk **unfit** for transportation? (Select all that apply.)

- ○ Bone fractures
- ○ Coat is still wet
- ○ Dehydration
- ○ Diarrhea/scours
- ○ Difficulty breathing
- ○ Extremely thin (BCS <2)
- ○ Has not received minimum colostrum feedings
- ○ Navel inflammation/infection
- ○ No ID tag
- ○ Premature birth (small size, fine hair coat)
- ○ Respiratory disease/pneumonia
- ○ Severe lameness/lame on one or more limbs
- ○ Unable to stand unassisted
- ○ Unable to walk unassisted
- ○ Other, please specify: _____

This portion of the survey asks about "preconditioning", which refers to management practices that are intended to help calves succeed during their next phase of production, such as during transportation, and after at calf-raising facilities, etc.

Q41. Which of the following are included in your preconditioning programs for **DAIRY BULL** calves on milk prior to transportation (other than colostrum, milk, water)? (Select all that apply.)

- ○ Antibiotics
- ○ Electrolytes
- ○ Navel dipping
- ○ Non-steroidal anti-inflammatory drugs
- ○ Supplements (i.e. prebiotics, probiotics, etc.)

- ○ Vaccinations
- ○ Other, please specify: _____

Q42. Would you be willing to implement additional preconditioning practices (e.g. antibiotics, electrolytes, non-steroidal anti-inflammatory drugs, supplements, vaccinations, etc.) for **DAIRY BULL** calves on milk prior to transport? (Select one.)

- ☐ Yes
- ☐ Maybe
- ☐ No

If you answered No to Q42., please proceed to Q44.

If you answered Yes or Maybe to Q42, please answer Q43.

Q43. What would the minimum premium or incentive ($ per head) need to be for you to implement additional preconditioning practices (e.g., antibiotics, electrolytes, non-steroidal anti-inflammatory drugs, supplements, vaccinations, etc.) for DAIRY BULL calves on milk prior to transport? Please specify $/head

_____ $/head

This next section asks you to consider ALL calves on milk (replacement heifers, dairy x beef, and dairy bull calves) that are transported off of your operation

Q50. What are your top **three** challenges related to transportation?

- ○ Calf health
- ○ Distance of calf facility from the operation
- ○ Drivers incorrectly identifying which calves were picked up
- ○ Finding buyers for calves
- ○ Labor costs/availability
- ○ Lack of employee training resources
- ○ Lack of resources (i.e. milk, housing, labor) to house calves prior to transport
- ○ Preparing calves for successful transportation (i.e.preconditioning)
- ○ Price for calves is too low
- ○ Space availability in case calf pick up is delayed
- ○ Times calves spend on track/trailer
- ○ Trailer conditions
- ○ Transportation logistics (i.e. distance, availability of drivers, etc.)
- ○ Other, please specify: _____

Q51. What are the top **three** resources that would be most helpful to address challenges related to calf transportation?

- ○ Best practices recommendations
- ○ Better understanding of driver turnover and/or driver schedule
- ○ Increased communication between the dairy and calf ranch by managers and leads
- ○ Increased preconditioning protocols
- ○ Increased premiums or sale price
- ○ Making it easier for driver to load calves onto the trailer
- ○ More markets for selling calves
- ○ Penalties or fines for poor handling or transportation of calves
- ○ Training programs for employees
- ○ Other, please specify: _____

Q52. Do employees who handle calves on milk immediately **prior** to transportation receive training? This may include maternity employees. (Select one.)

- ☐ Yes
- ☐ No

If you selected No for Q52., please proceed to Q53.

If you selected Yes for Q52., please answer Q52.1 and Q52.2

Q52.1. What topics are discussed in training programs for employees who handle calves on milk immediately prior to transportation? (Select all that apply.)

- ○ Calf handling
- ○ Colostrum collection, testing, and storage
- ○ Colostrum feeding
- ○ Disease identification
- ○ Human health and safety
- ○ Newborn calf care (navel dipping, ear tagging, etc.)
- ○ Record keeping
- ○ Other, please specify: _____

Q52.2. In what format is training provided to employees who handle calves on milk immediately prior to transportation? (Select all that apply.)

- ○ Trained by another employee (i.e. not a manager)
- ○ Trained by herd veterinarian
- ○ Trained by manager
- ○ Trained through Beef Quality Assurance (BQA) program
- ○ Trained through Beef Quality Assurance Transportation (BQAT) program with specific information about transporting calves on milk
- ○ Trained through Calf Care and Quality Assurance (CCQA) program
- ○ Video training
- ○ Other, please specify: _____

Q53. Is there anything else you would like to share regarding transporting calves on milk?

_____

Q54. What is your role on the operation? (Select all that apply.)

- ○ Owner
- ○ Manager
- ○ Employee who makes decisions about calves
- ○ Other, please specify: _____

Q55. What is your current age? (Select one.)

- ☐ 18-29
- ☐ 30-39
- ☐ 40-49
- ☐ 50-59
- ☐ 60-69
- ☐ 70+

Q56. How many lactating cows are on your operation? (Select one.)

- ☐ Less than 80
- ☐ 80-200
- ☐ 200-500
- ☐ 500-1000
- ☐ More than 1000
- ☐ Other, please specify: _____

Q57. Where is your operation located in the United States? (Select one.)

- ☐ Midwest (IA,IL,IN,KS,MI,MN,MS,ND,NE,OH,SD,WI)
- ☐ Northeast (CT,DE,MA,ME,MD,NH,NJ,NY,PA,VT,RI)
- ☐ Southeast (AL,AR,FL,GA,LA,KY,MS,NC,SC,TN,VA,WV)
- ☐ Southwest (AZ,NM,OK,TX)
- ☐ West (CA,CO,ID,MT,NV,OR,UT,WA,WY)
- ☐ Outside of the United States

Q58. How did you hear about this survey? (Select one.)

- ☐ Convention/Meeting/Workshop
- ☐ Email
- ☐ Flyer
- ☐ Herd Veterinarian
- ☐ Online advertisement
- ☐ Other, please specify: _____

Q59. Which gender do you most identify with? (Select one.)

- ☐ Male
- ☐ Female

- [ ] Do not identify as man or woman
- [ ] Prefer not to say

Thank you for taking this survey. To receive your $15 gift card, please provide your email. We will distribute gift cards within 3-4 weeks of participation.

_____

Would you be interested in participating in workshops, training, or research related to calf transportation?

- [ ] Yes
- [ ] No

If so, may we contact you at this email about future opportunities?

- [ ] Yes
- [ ] No

Survey of Current Dairy Industry Practices for Preweaned Calf Transportation Dairies

Colorado State University is conducting a research survey to describe current industry practices regarding the transportation of dairy or dairy x beef calves on milk in the **United States**. We want to hear from anyone making decisions about the transportation and/or receiving of dairy or dairy x beef calves on milk. That includes producers, owners, operators, or managers on dairies, calf ranches, heifer-raising facilities, and veal operations, as well as transportation drivers. Participants in the research must be over 18 years of age.

Thank you for taking the time to fill out this research survey. For each question that has a fill-in option, you are welcome to add your own selection if you feel it is not best described by one of the choices. The open-ended questions are intended for you to share your personal opinions or experiences. We anticipate the survey should take 15-20 minutes to complete.

Your responses are completely anonymous and will not be used for any purpose other than for our research. There are minimal risks to participating in this survey and you may choose to stop at any time. All responses will be summarized and reported at the aggregate level.

Thank you for taking this survey. If you have any questions about this research project, please contact:

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Dr. Sarah Depenbrock, DVM, MS, DACVIM
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Associate Professor
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Colorado State University

Dr. Noa Roman-Muniz, DVM, MS
Professor and Director of Undergraduate Programs
Department of Animal Sciences
Colorado State University

If you have questions about your rights or welfare as a participant, please contact the CSU Institutional Review Board, at (970) 491-1553 or by email at CSU_IRB@mail.colostate.edu.

CONSENT TO PARTICIPATE QUESTION

☐ Yes, I agree that I am over 18 years of age and consent to participate in this study
☐ No, I do not consent to participate in this study

The main goals of this study are to better understand current industry practices for transporting calves on milk and if these practices differ between replacement heifers, dairy x beef, and dairy bull calves. We want to understand producers' challenges and needs in this area to identify research and outreach efforts.
For each question, circle your selected answer(s) or fill in the requested information.

This section of the survey asks about replacement heifer calves on milk (heifers that are intended for dairy cow replacements) that are transported off site. Other sections will ask about dairy x beef and dairy bull calves.

Q1. In the last year, approximately how many total **REPLACEMENT HEIFER** calves on milk were transported off the operation prior to weaning? Please only use numbers and do not provide ranges.

_____

If you answer 0 to Q1., please proceed to Q16.

Q2. For these **REPLACEMENT HEIFER** calves on milk that were transported off your operation prior to weaning, will these animals eventually return to your operation? (Select one.)

☐ Yes
☐ No
☐ Other, please specify: _____

Q3. Was colostrum provided to newborn **REPLACEMENT HEIFER** calves prior to transportation? (Select one.)

☐ Yes
☐ No
☐ Other, please specify: _____

If you selected No for Q3., please proceed to Q4.

If you selected Yes or Other for Q3., please answer Q3.1 through Q3.4

Q3.1. How soon after birth was the FIRST colostrum feeding provided to the majority (>50%) of newborn **REPLACEMENT HEIFER** calves? (Select one.)

- ☐ < 1 hour
- ☐ 1-2 hours
- ☐ 3-4 hours
- ☐ 4-5 hours
- ☐ ≥ 6 hours

Q3.2 Which of the following best describes the colostrum quality fed to the majority (>50%) of newborn **REPLACEMENT HEIFER** calves at their FIRST feeding? (Select one.)

- ☐ BRIX reading ≥ 22 (IgG ≥ 50 g/L)
- ☐ BRIX reading < 22 (IgG < 50 g/L)
- ☐ BRIX or IgG is unknown

Q3.3 On average, how much TOTAL colostrum (all feedings) was fed to newborn **REPLACEMENT HEIFER** (for a 100lb Holstein calf) prior to transportation? (Select one.)

- ☐ 1quart (1L)
- ☐ 2quarts (2L)
- ☐ 3quarts (3L)
- ☐ ≥ 4quarts (1 gallon or 4L)

Q3.4 What system do you use, if any, to ensure a newborn **REPLACEMENT HEIFER** calf has received enough colostrum and can be transported off your facility? (Select all that apply.)

- ○ Chalk or paint marks on the calf
- ○ Paper records
- ○ Dairy employees communicate with driver
- ○ Serum IgG levels
- ○ We currently do not have a system
- ○ Other, please specify: _____

Q4. Which, if any, of the following would influence your decision to improve your colostrum practices for newborn **REPLACEMENT HEIFER** calves prior to transportation? (Select all that apply.)

- ◯ Employee training
- ◯ Premium paid by the buyer ($/head)
- ◯ To avoid penalty by buyer
- ◯ To improve calf health
- ◯ To meet a third-party audit standard
- ◯ To meet calf raiser standards
- ◯ To meet buyer standards
- ◯ Other, please specify: _____
- ◯ I will not improve my colostrum practices
- ◯ I already have excellent colostrum program for replacement heifer calves

Q5. For **REPLACEMENT HEIFER** calves on milk ≥12 hours of age at the time of transportation, do you provide a milk feeding within 2 hours prior to being transported? (Select one.)

- ☐ Yes
- ☐ No
- ☐ Other, please specify: _____

Q6. For **REPLACEMENT HEIFER** calves on milk ≥12 hours of age at the time of transportation, did calves have access to water immediately prior to being transported? (Select one.)

- ☐ Yes
- ☐ No
- ☐ Other, please specify: _____

Q7. Within the last year, at what age were the majority (>50%) of **REPLACEMENT HEIFER** calves on milk transported off-site? (Select one.)

- ☐ Less than 24hrs
- ☐ 1 day
- ☐ 2 days
- ☐ 3 days
- ☐ 4-7 days
- ☐ 7-14 days
- ☐ >14 days, but before weaning

Q8. Within the last year, where were the majority (>50%) of **REPLACEMENT HEIFER** calves transported after leaving your facility? (Select one.)

- ☐ Auction or livestock market
- ☐ Calf dealer/jockey
- ☐ Calf ranch or heifer raiser
- ☐ Veal facility
- ☐ Culled or euthanized before transportation
- ☐ Other, please specify: _____

Q9. For the destination selected above, how many MILES on average were **REPLACEMENT HEIFER** calves transported? (Select one.)

☐ _____ miles
☐ I do not know

Q10. For the destination selected above, how many HOURS on average were **REPLACEMENT HEIFER** calves transported? (Select one.)

☐ _____ hours
☐ I do not know

Q11. Do you conduct a formal assessment of **REPLACEMENT HEIFER** calf health prior to transportation? (Select one.)

☐ Yes
☐ No

Q12. Which of the following would deem a **REPLACEMENT HEIFER** calf on milk **unfit** for transportation? (Select all that apply.)

○ Bone fractures
○ Coat is still wet
○ Dehydration
○ Diarrhea/scours
○ Difficulty breathing
○ Extremely thin (BCS <2)
○ Has not received minimum colostrum feedings
○ Navel inflammation/infection
○ No ID tag
○ Premature birth (small size, fine hair coat)
○ Respiratory disease/pneumonia
○ Severe lameness/lame on one or more limbs
○ Unable to stand unassisted

○ Unable to walk unassisted

○ Other, please specify: _____

This portion of the survey asks about "preconditioning", which refers to management practices that are intended to help calves succeed during their next phase of production, such as during transportation, and after at calf-raising facilities, etc.

Q13. Which of the following are included in your preconditioning programs for **REPLACEMENT HEIFER** calves on milk prior to transportation (other than colostrum, milk, water)? (Select all that apply.)

○ Antibiotics

○ Electrolytes

○ Navel dipping

○ Non-steroidal anti-inflammatory drugs

○ Supplements (i.e. prebiotics, probiotics, etc.)

○ Vaccinations

○ Other, please specify: _____

○ Nothing (other than colostrum, water, and milk) is provided

Q14. Would you be willing to implement additional preconditioning practices (e.g. antibiotics, electrolytes, non-steroidal anti-inflammatory drugs, supplements, vaccinations, etc.) for **REPLACEMENT HEIFER** calves on milk prior to transport? (Select one.)

☐ Yes

☐ Maybe

☐ No

If you answered No to Q14., please proceed to Q16.

If you answered Yes or Maybe to Q14., please answer Q15.

Q15. What would the minimum premium or incentive ($ per head) need to be for you to implement additional preconditioning practices (e.g., antibiotics, electrolytes, non-steroidal anti-inflammatory drugs, supplements, vaccinations, etc.) for **REPLACEMENT HEIFER** calves on milk prior to transport? Please specify $/head

_____ $/head

This section of the survey asks about DAIRY x BEEF calves on milk that are transported off of your operation. A subsequent section will ask about dairy bull calves.

Q16. In the last year, approximately how many total **DAIRY x BEEF** calves on milk were transported off of your operation prior to weaning? Please only use numbers and do not provide ranges.

_____

If you answer 0 to Q16., please proceed to Q30.

Q17. Was colostrum provided to newborn **DAIRY x BEEF** calves prior to transportation? (Select one.)

☐ Yes

☐ No

If you selected No for Q17., please proceed to Q18.

If you selected Yes or Other for Q17., please answer Q17.1 through Q17.4

Q17.1 How soon after birth was the first colostrum feeding provided to the majority (>50%) of newborn **DAIRY x BEEF** calves? (Select one.)

- ☐ < 1 hour
- ☐ 1-2 hours
- ☐ 3-4 hours
- ☐ 4-5 hours
- ☐ ≥ 6 hours

Q17.2 Which of the following best describes the colostrum quality fed to the majority (>50%) of newborn **DAIRY x BEEF** calves at their FIRST feeding? (Select one.)

- ☐ BRIX reading ≥ 22 (IgG ≥ 50 g/L)
- ☐ BRIX reading < 22 (IgG < 50 g/L)
- ☐ BRIX or IgG is unknown

Q17.3 On average, how much TOTAL colostrum (all feedings) was fed to newborn **DAIRY x BEEF** (for a 100lb Holstein calf) <u>prior to transportation?</u> (Select one.)

- ☐ 1quart (1L)
- ☐ 2quarts (2L)
- ☐ 3quarts (3L)
- ☐ ≥ 4quarts (1 gallon or 4L)

Q17.4 What system do you use, if any, to ensure a newborn **DAIRY x BEEF** calf has received enough colostrum and can be transported off your facility? (Select all that apply.)

- ○ Chalk or paint marks on the calf
- ○ Paper records
- ○ Dairy employees communicate with driver
- ○ Serum IgG levels
- ○ We currently do not have a system
- ○ Other, please specify: _____

Q18. Which, if any, of the following would influence your decision to improve your colostrum practices for newborn **DAIRY x BEEF** calves prior to transportation? (Select all that apply.)

- ○ Employee training
- ○ Premium paid by the buyer ($/head)
- ○ To avoid penalty by buyer
- ○ To improve calf health
- ○ To meet a third-party audit standard
- ○ To meet calf raiser standards
- ○ To meet buyer standards
- ○ Other, please specify: _____
- ○ I will not improve my colostrum practices
- ○ I already have excellent colostrum program for replacement heifer calves

Q19. For **DAIRY x BEEF** calves on milk ≥12 hours of age at the time of transportation, do you provide a milk feeding within 2 hours prior to being transported? (Select one.)

- ☐ Yes
- ☐ No
- ☐ Other, please specify: _____

Q20. For **DAIRY x BEEF** calves on milk ≥12 hours of age at the time of transportation, did calves have access to water immediately prior to being transported? (Select one.)

- ☐ Yes
- ☐ No
- ☐ Other, please specify: _____

Q21. Within the last year, at what age were the majority (>50%) of **DAIRY x BEEF** calves on milk transported off-site? (Select one.)

- ☐ Less than 24hrs
- ☐ 1 day
- ☐ 2 days
- ☐ 3 days
- ☐ 4-7 days
- ☐ 7-14 days
- ☐ >14 days, but before weaning

Q22. Within the last year, where were the majority (>50%) of **DAIRY x BEEF** calves transported after leaving your facility? (Select one.)

- ☐ Auction or livestock market
- ☐ Calf dealer/jockey
- ☐ Calf ranch or heifer raiser
- ☐ Veal facility
- ☐ Culled or euthanized before transportation
- ☐ Other, please specify: _____

Q23. For the destination selected above, how many MILES on average were **DAIRY x BEEF** calves transported? (Select one.)

☐ _____ miles
☐ I do not know

Q24. For the destination selected above, how many HOURS on average were **DAIRY x BEEF** calves transported? (Select one.)

☐ _____ hours
☐ I do not know

Q25. Do you conduct a formal assessment of **DAIRY x BEEF** calf health prior to transportation? (Select one.)

☐ Yes
☐ No

Q26. Which of the following would deem a **DAIRY x BEEF** calf on milk **unfit** for transportation? (Select all that apply.)

○ Bone fractures
○ Coat is still wet
○ Dehydration
○ Diarrhea/scours
○ Difficulty breathing
○ Extremely thin (BCS <2)
○ Has not received minimum colostrum feedings
○ Navel inflammation/infection
○ No ID tag
○ Premature birth (small size, fine hair coat)
○ Respiratory disease/pneumonia
○ Severe lameness/lame on one or more limbs
○ Unable to stand unassisted

○ Unable to walk unassisted

○ Other, please specify: _____

This portion of the survey asks about "preconditioning", which refers to management practices that are intended to help calves succeed during their next phase of production, such as during transportation, and after at calf-raising facilities, etc.

Q27. Which of the following are included in your preconditioning programs for **DAIRY x BEEF** calves on milk prior to transportation (other than colostrum, milk, water)? (Select all that apply.)

○ Antibiotics

○ Electrolytes

○ Navel dipping

○ Non-steroidal anti-inflammatory drugs

○ Supplements (i.e. prebiotics, probiotics, etc.)

○ Vaccinations

○ Other, please specify: _____

○ Nothing (other than colostrum, water, and milk) is provided

Q28. Would you be willing to implement additional preconditioning practices (e.g. antibiotics, electrolytes, non-steroidal anti-inflammatory drugs, supplements, vaccinations, etc.) for **DAIRY x BEEF** calves on milk prior to transport? (Select one.)

☐ Yes

☐ Maybe

☐ No

If you answered No to Q28., please proceed to Q30.

If you answered Yes or Maybe to Q28., please answer Q29.

Q29. What would the minimum premium or incentive ($ per head) need to be for you to implement additional preconditioning practices (e.g., antibiotics, electrolytes, non-steroidal anti-inflammatory drugs,

supplements, vaccinations, etc.) for **DAIRY x BEEF** calves on milk prior to transport? Please specify $/head

_____ $/head

This section of the survey asks about DAIRY BULL calves on milk that are transported off of your operation.

Q30. In the last year, approximately how many total **DAIRY BULL** calves on milk were transported off of your operation prior to weaning? Please only use numbers and do not provide ranges.

_____

If you answer 0 to Q30., please proceed to Q44.

Q31. Was colostrum provided to newborn **DAIRY BULL** calves prior to transportation? (Select one.)

☐ Yes

☐ No

If you selected No for Q31., please proceed to Q32.

If you selected Yes or Other for Q31., please answer Q31.1 through Q31.4

Q31.1 How soon after birth was the first colostrum feeding provided to the majority (>50%) of newborn **DAIRY BULL** calves? (Select one.)

☐ < 1 hour

☐ 1-2 hours

☐ 3-4 hours

☐ 4-5 hours

☐ ≥ 6 hours

Q31.2 Which of the following best describes the colostrum quality fed to the majority (>50%) of newborn **DAIRY BULL** calves at their FIRST feeding? (Select one.)

☐ BRIX reading ≥ 22 (IgG ≥ 50 g/L)

☐ BRIX reading < 22 (IgG < 50 g/L)

☐ BRIX or IgG is unknown

Q31.3 On average, how much TOTAL colostrum (all feedings) was fed to newborn **DAIRY BULL** (for a 100lb Holstein calf) prior to transportation? (Select one.)

- ☐ 1quart (1L)
- ☐ 2quarts (2L)
- ☐ 3quarts (3L)
- ☐ ≥ 4quarts (1 gallon or 4L)

Q31.4 What system do you use, if any, to ensure a newborn **DAIRY BULL** calf has received enough colostrum and can be transported off your facility? (Select all that apply.)

- ○ Chalk or paint marks on the calf
- ○ Paper records
- ○ Dairy employees communicate with driver
- ○ Serum IgG levels
- ○ We currently do not have a system
- ○ Other, please specify: _____

Q32. Which, if any, of the following would influence your decision to improve your colostrum practices for newborn **DAIRY BULL** calves prior to transportation? (Select all that apply.)

- ○ Employee training
- ○ Premium paid by the buyer ($/head)
- ○ To avoid penalty by buyer
- ○ To improve calf health
- ○ To meet a third-party audit standard
- ○ To meet calf raiser standards
- ○ To meet buyer standards
- ○ Other, please specify: _____
- ○ I will not improve my colostrum practices
- ○ I already have excellent colostrum program for replacement heifer calves

Q33. For **DAIRY BULL** calves on milk ≥12 hours of age at the time of transportation, do you provide a milk feeding within 2 hours prior to being transported? (Select one.)

- ☐ Yes
- ☐ No
- ☐ Other, please specify: _____

Q34. For **DAIRY BULL** calves on milk ≥12 hours of age at the time of transportation, did calves have access to water immediately prior to being transported? (Select one.)

- ☐ Yes
- ☐ No
- ☐ Other, please specify: _____

Q35. Within the last year, at what age were the majority (>50%) of **DAIRY BULL** calves on milk transported off-site? (Select one.)

- ☐ Less than 24hrs
- ☐ 1 day
- ☐ 2 days
- ☐ 3 days
- ☐ 4-7 days
- ☐ 7-14 days
- ☐ >14 days, but before weaning

Q36. Within the last year, where were the majority (>50%) of **DAIRY BULL** calves transported after leaving your facility? (Select one.)

- ☐ Auction or livestock market
- ☐ Calf dealer/jockey
- ☐ Calf ranch or heifer raiser
- ☐ Veal facility
- ☐ Culled or euthanized before transportation
- ☐ Other, please specify: _____

Q37. For the destination selected above, how many MILES on average were **DAIRY BULL** calves transported? (Select one.)

☐ _____ miles
☐ I do not know

Q38. For the destination selected above, how many HOURS on average were **DAIRY BULL** calves transported? (Select one.)

☐ _____ hours
☐ I do not know

Q39. Do you conduct a formal assessment of **DAIRY BULL** calf health prior to transportation?

☐ Yes
☐ No

Q40. Which of the following would deem a **DAIRY BULL** calf on milk **unfit** for transportation? (Select all that apply.)

○ Bone fractures
○ Coat is still wet
○ Dehydration
○ Diarrhea/scours
○ Difficulty breathing
○ Extremely thin (BCS <2)
○ Has not received minimum colostrum feedings
○ Navel inflammation/infection
○ No ID tag
○ Premature birth (small size, fine hair coat)
○ Respiratory disease/pneumonia
○ Severe lameness/lame on one or more limbs
○ Unable to stand unassisted
○ Unable to walk unassisted
○ Other, please specify: _____

This portion of the survey asks about "preconditioning", which refers to management practices that are intended to help calves succeed during their next phase of production, such as during transportation, and after at calf-raising facilities, etc.

Q41. Which of the following are included in your preconditioning programs for **DAIRY BULL** calves on milk prior to transportation (other than colostrum, milk, water)? (Select all that apply.)

- ○ Antibiotics
- ○ Electrolytes
- ○ Navel dipping
- ○ Non-steroidal anti-inflammatory drugs
- ○ Supplements (i.e. prebiotics, probiotics, etc.)
- ○ Vaccinations
- ○ Other, please specify: _____
- ○ Nothing (other than colostrum, water, and milk) is provided

Q42. Would you be willing to implement additional preconditioning practices (e.g. antibiotics, electrolytes, non-steroidal anti-inflammatory drugs, supplements, vaccinations, etc.) for **DAIRY BULL** calves on milk prior to transport? (Select one.)

- ☐ Yes
- ☐ Maybe
- ☐ No

If you answered No to Q42., please proceed to Q44.

If you answered Yes or Maybe to Q42., please answer Q43.

Q43. What would the minimum premium or incentive ($ per head) need to be for you to implement additional preconditioning practices (e.g., antibiotics, electrolytes, non-steroidal anti-inflammatory drugs,

supplements, vaccinations, etc.) for **DAIRY BULL** calves on milk prior to transport? Please specify $/head

_____ $/head

This portion of the survey asks about calf management AFTER transportation

Q44. Do you conduct a formal assessment of calf health when they arrive at your operation? (Select one.)

☐ Yes

☐ No

Q45. Do you collect blood samples from calves to determine transfer of passive immunity status?

☐ Yes

☐ No

Q46. In the last year, did calves on milk arrive to your operation with any of the following conditions? (Select all that apply).

○ Bone fractures

○ Coat is still wet

○ Dehydration

○ Diarrhea/scours

○ Difficulty breathing

○ Extremely thin (BCS <2)

○ Has not received minimum colostrum feedings

○ Navel inflammation/infection

○ No ID tag

○ Premature birth (small size, fine hair coat)

○ Respiratory disease/pneumonia

○ Severe lameness/lame on one or more limbs

○ Unable to stand unassisted

○ Unable to walk unassisted

○ Other, please specify: _____

Q47. This question asks about all calves on milk raised on your facility. In the last year, approximately what percentage of calves on milk were affected with each of the following?

Diarrhea/gastrointestinal

_____

Navel inflammation/infection

_____

Respiratory/pneumonia

_____

Q48. In the last year, approximately what <u>percent</u> of calves on milk that arrived on your operation subsequently died before weaning?

_____

This next section asks you to consider ALL calves on milk (replacement heifers, dairy x beef, and dairy bull calves) that are transported off of your operation

Q49. What are your top **three** challenges related to transportation?

- ◯ Calf health
- ◯ Distance of calf facility from the operation
- ◯ Drivers incorrectly identifying which calves were picked up
- ◯ Finding buyers for calves
- ◯ Labor costs/availability
- ◯ Lack of employee training resources
- ◯ Lack of resources (i.e. milk, housing, labor) to house calves prior to transport
- ◯ Preparing calves for successful transportation (i.e.preconditioning)
- ◯ Price for calves is too low
- ◯ Space availability in case calf pick up is delayed
- ◯ Times calves spend on track/trailer
- ◯ Trailer conditions

◯ Transportation logistics (i.e. distance, availability of drivers, etc.)

◯ Other, please specify: _____

Q50. What are the top **three** resources that would be most helpful to address challenges related to calf transportation?

◯ Best practices recommendations

◯ Better understanding of driver turnover and/or driver schedule

◯ Increased communication between the dairy and calf ranch by managers and leads

◯ Increased preconditioning protocols

◯ Increased premiums or sale price

◯ Making it easier for driver to load calves onto the trailer

◯ More markets for selling calves

◯ Penalties or fines for poor handling or transportation of calves

◯ Training programs for employees

◯ Other, please specify: _____

Q51. Do employees who handle calves on milk immediately **prior** to transportation receive training? This may include maternity employees. (Select one.)

☐ Yes

☐ No

If you selected No for Q51., please proceed to Q52.

If you selected Yes for Q51., please answer Q51.1 and Q51.2

Q51.1. What topics are discussed in training programs for employees who handle calves on milk immediately prior to transportation? (Select all that apply.)

- ◯ Calf handling
- ◯ Colostrum collection, testing, and storage
- ◯ Colostrum feeding
- ◯ Disease identification
- ◯ Human health and safety
- ◯ Newborn calf care (navel dipping, ear tagging, etc.)
- ◯ Record keeping
- ◯ Other, please specify: _____

Q51.2. In what format is training provided to employees who handle calves on milk immediately prior to transportation? (Select all that apply.)

- ◯ Trained by another employee (i.e. not a manager)
- ◯ Trained by herd veterinarian
- ◯ Trained by manager
- ◯ Trained through Beef Quality Assurance (BQA) program
- ◯ Trained through Beef Quality Assurance Transportation (BQAT) program with specific information about transporting calves on milk
- ◯ Trained through Calf Care and Quality Assurance (CCQA) program
- ◯ Video training
- ◯ Other, please specify: _____

Q52. Do employees who handle calves on milk immediately **after** transportation (i.e. from the dairy of origin) receive training? (Select one.)

- ☐ Yes
- ☐ No

If you selected No for Q52., please proceed to Q53.

If you selected Yes for Q52., please answer Q52.1 and Q52.2

Q52.1. What topics are discussed in training programs for employees who handle calves on milk immediately prior to transportation? (Select all that apply.)

- ○ Calf handling
- ○ Colostrum collection, testing, and storage
- ○ Colostrum feeding
- ○ Disease identification
- ○ Human health and safety
- ○ Newborn calf care (navel dipping, ear tagging, etc.)
- ○ Record keeping
- ○ Other, please specify: _____

Q52.2. In what format is training provided to employees who handle calves on milk immediately prior to transportation? (Select all that apply.)

- ○ Trained by another employee (i.e. not a manager)
- ○ Trained by herd veterinarian
- ○ Trained by manager
- ○ Trained through Beef Quality Assurance (BQA) program
- ○ Trained through Beef Quality Assurance Transportation (BQAT) program with specific information about transporting calves on milk
- ○ Trained through Calf Care and Quality Assurance (CCQA) program
- ○ Video training
- ○ Other, please specify: _____

Q53. Is there anything else you would like to share regarding transporting calves on milk?

_____

Q54. What is your role on the operation? (Select all that apply.)

- ○ Owner
- ○ Manager
- ○ Employee who makes decisions about calves
- ○ Other, please specify: _____

Q55. What is your current age? (Select one.)

- ☐ 18-29

☐ 30-39

☐ 40-49

☐ 50-59

☐ 60-69

☐ 70+

Q56. How many lactating cows are on your operation? (Select one.)

☐ Less than 80

☐ 80-200

☐ 200-500

☐ 500-1000

☐ More than 1000

☐ Other, please specify: _____

Q57. Where is your operation located in the United States? (Select one.)

☐ Midwest (IA,IL,IN,KS,MI,MN,MS,ND,NE,OH,SD,WI)

☐ Northeast (CT,DE,MA,ME,MD,NH,NJ,NY,PA,VT,RI)

☐ Southeast (AL,AR,FL,GA,LA,KY,MS,NC,SC,TN,VA,WV)

☐ Southwest (AZ,NM,OK,TX)

☐ West (CA,CO,ID,MT,NV,OR,UT,WA,WY)

☐ Outside of the United States

Q58. How did you hear about this survey? (Select one.)

☐ Convention/Meeting/Workshop

☐ Email

☐ Flyer

☐ Herd Veterinarian

☐ Online advertisement

☐ Other, please specify: _____

Q59. Which gender do you most identify with? (Select one.)

- ☐ Male
- ☐ Female
- ☐ Do not identify as man or woman
- ☐ Prefer not to say

Thank you for taking this survey. To receive your $15 gift card, please provide your email. We will distribute gift cards within 3-4 weeks of participation.

_____

Would you be interested in participating in workshops, training, or research related to calf transportation?

Yes/No

If so, may we contact you at this email about future opportunities?

Yes/No

Survey of Current Dairy Industry Practices for Preweaned Calf Transportation

Calf Raisers

Colorado State University is conducting a research survey to describe current industry practices regarding the transportation of dairy or dairy x beef calves on milk in the **United States**. We want to hear from anyone making decisions about the transportation and/or receiving of dairy or dairy x beef calves on milk. That includes producers, owners, operators, or managers on dairies, calf ranches, heifer-raising facilities, and veal operations, as well as transportation drivers. Participants in the research must be over 18 years of age.

Thank you for taking the time to fill out this research survey. For each question that has a fill-in option, you are welcome to add your own selection if you feel it is not best described by one of the choices. The open-ended questions are intended for you to share your personal opinions or experiences. We anticipate the survey should take 15-20 minutes to complete.

Your responses are completely anonymous and will not be used for any purpose other than for our research. There are minimal risks to participating in this survey and you may choose to stop at any time. All responses will be summarized and reported at the aggregate level.

Thank you for taking this survey. If you have any questions about this research project, please contact:
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Dr. Sarah Depenbrock, DVM, MS, DACVIM
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Department of Medicine and Epidemiology
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Dr. Lily Edwards-Callaway, MS, PhD
Associate Professor
Department of Animal Sciences
Colorado State University

Dr. Noa Roman-Muniz, DVM, MS
Professor and Director of Undergraduate Programs
Department of Animal Sciences
Colorado State University

If you have questions about your rights or welfare as a participant, please contact the CSU Institutional Review Board, at (970) 491-1553 or by email at CSU_IRB@mail.colostate.edu.

CONSENT TO PARTICIPATE QUESTION

- ☐ Yes, I agree that I am over 18 years of age and consent to participate in this study
- ☐ No, I do not consent to participate in this study

The main goals of this study are to better understand current industry practices for transporting calves on milk and if these practices differ between replacement heifers, dairy x beef, and dairy bull calves. We want to understand producers' challenges and needs in this area to identify research and outreach efforts.

For each question, mark your selected answer(s) or fill in the requested information.

Q1. Within the last year, approximately how far of a distance between the dairy of origin and your operation did the majority (>50%) of calves on milk travel?

- ☐ ≤ 50 miles away
- ☐ 51-100 miles away
- ☐ 101-500 miles away
- ☐ 501-1000 miles away
- ☐ >1000 miles away
- ☐ I do not know

Q2. Within the last year, approximately what age were the majority (>50%) of calves on milk that arrived at your facility? (Select one.)

- ☐ ≤ 24 hours old
- ☐ 1 day old
- ☐ 2 days old
- ☐ 3 days old
- ☐ 4-7 days old
- ☐ 7-14 days old

Q3. Over the past year, approximately what percentage of calves on milk that arrive at your facility were: please provide a number and not ranges

Beef x Dairy (male and female) _____%

Holstein female _____%

Dairy bull calves (ex: Holstein or Jersey males) _____%

Q4. Do you conduct a formal assessment of calf health when they arrive at your operation?

- ☐ Yes
- ☐ No

Q5. Do you collect blood samples from calves to determine transfer of passive immunity status?

- ☐ Yes
- ☐ No

Q6. In the last year, did calves on milk **arrive** to your operation with any of the following conditions? (Select all that apply.)

- ○ Bone Fractures
- ○ Dehydration
- ○ Difficulty breathing/labored breathing
- ○ Diarrhea/scours
- ○ Extremely thin (BCS below 2)
- ○ Failed transfer of passive immunity (i.e. low total proteins)
- ○ Navel inflammation/infection
- ○ Non-ambulatory
- ○ Open wounds
- ○ Respiratory disease/pneumonia
- ○ Severe lameness/lame on one or more limbs

Q7. This question asks about all calves on milk raised on your facility. In the last year, approximately what percentage of calves on milk were affected with each of the following:

Please provide a number and not ranges

Diarrhea/gastrointestinal _____%

Navel inflammation/infection _____%

Respiratory/pneumonia _____%

Q8. In the last year, approximately what percent of calves on milk that arrived on your operation subsequently died before weaning?

_____%

This portion of the survey asks about "preconditioning", which refers to management practices that are intended to help calves succeed during their next phase of production, such as during transportation and after at calf-raising facilities, etc.

Q9. Do you require your source operations to provide any of the following preconditioning practices to calves on milk that are transported to your facility? (Select all that apply.)

- ○ Antibiotics
- ○ Colostrum
- ○ Electrolytes before transport
- ○ Electrolytes during transport
- ○ Milk before transport
- ○ Milk during transport
- ○ Non-steroidal anti-inflammatory drugs
- ○ Vaccinations
- ○ Water before transport
- ○ Water during transport
- ○ Other, please specify _____
- ○ I do not have any preconditioning requirements for the source farm

Q10. Select the top **three** preconditioning aspects that you feel are the most important for calves on milk that are transported to your facility.

- ○ Antibiotics
- ○ Colostrum
- ○ Electrolytes before transport
- ○ Electrolytes during transport
- ○ Milk before transport
- ○ Milk during transport
- ○ Non-steroidal anti-inflammatory drugs
- ○ Vaccinations
- ○ Water before transport
- ○ Water during transport
- ○ Other, please specify _____

Q11.Would you be willing to require source farms to have preconditioning practices (e.g., antibiotics, electrolytes, non-steroidal anti-inflammatory drugs, supplements, vaccinations, etc.), in addition to what is already done, for calves on milk prior to transportation? (Select one.)

- ☐ Yes

☐ Maybe
☐ No

If you selected No or I am the owner of the calves for Q11, please proceed to Q12.

If you selected Yes or Maybe for Q11, answer Q11.1 below

11.1 What premium or incentive would you be willing to provide for additional preconditioning practices (e.g., antibiotics, electrolytes, non-steroidal anti-inflammatory drugs, supplements, vaccinations, etc.) for calves on milk prior to transport?

_____$/head

12. Do employees who handle calves on milk immediately **after** transportation (i.e., from the dairy of origin) receive training? (Select one.)

☐ Yes
☐ No

If answer to Q12 = No, skip to Q13

If answer to Q12 = Yes, answer Q12.1 and Q12.2 below:

12.1 What topics are discussed in training programs for employees who handle calves on milk immediately after transportation? (Select all that apply.)

○ Calf handling
○ Colostrum management
○ Disease identification
○ Human health and safety
○ Newborn care (navel dipping, ear tagging, etc.)
○ Record-keeping
○ Sanitation
○ Transfer of passive immunity (e.g. serum total proteins, antibodies, etc.)
○ Other, please specify: _____

12.2 In what format is training provided to employees who handle calves on milk immediately prior to transportation? (Select all that apply.)

○ Trained by another employee (i.e. not a manager)
○ Trained by herd veterinarian

- ○ Trained by manager
- ○ Trained through Beef Quality Assurance (BQA) program with specific information about transporting calves on milk
- ○ Trained through Beef Quality Assurance Transportation (BQAT) program with specific information about transporting calves on milk
- ○ Trained through Calf Care and Quality Assurance (CCQA) program
- ○ Trained through Farmers Assuring Responsible Management (FARM) program
- ○ Video training
- ○ Other, please specify: _____

Q13. What are your top **three** challenges related to calf transportation?

- ○ Distance of calf facility from dairies
- ○ Drivers incorrectly identifying which calves were picked up
- ○ Finding a buyer for calves
- ○ Labor costs/availability
- ○ Lack of employee training resources
- ○ Lack of resources (i.e. milk, housing, labor) to house calves prior to transport
- ○ Preparing calves for successful transportation (i.e. preconditioning).
- ○ Price for calves is too low
- ○ Space availability is case calf pick up is delayed
- ○ Time calves spend on the truck/trailer
- ○ Trailer conditions
- ○ Transportation logistics (i.e. distance, availability of drivers, etc.)
- ○ Other, please specify:_____

Q14. What are the top **three** resources that would be most helpful to address challenges related to calf transportation?

- ○ Best practices recommendations
- ○ Better understanding of driver turnover and/or driver schedule
- ○ Increased communication between drivers, dairies, and calf ranches
- ○ Increased premiums or sale price
- ○ Making it easier for driver to load calves onto the trailer
- ○ More options/markets for selling surplus calves
- ○ Penalties or fines for poor handling or transportation of calves
- ○ Training programs for employees
- ○ Other, please specify: _____

Q15. Is there anything else you would like to share regarding transporting calves on milk?

_____

Q16. Which of the following best describes your operation? Select all that apply.

- ☐ Auction or livestock market
- ☐ Calf ranch (raise calves on milk that originated from a dairy)
- ☐ Veal
- ☐ Other, please specify: _____

If you did not answer Calf ranch to Q16., please proceed to Q17.

If you answer Calf ranch to Q16., please answer Q16.1

Q16.1. What is the primary purpose of your operation? (Select one.)

- ☐ Raise calves for subsequent beef or production
- ☐ Raise calves for replacement heifers
- ☐ All of the above

Q17. What is your role on the operation? Select all that apply

- ☐ Owner
- ☐ Manager
- ☐ Employee who makes decisions about calves
- ☐ Other, please specify: _____

Q18. What is your current age? (Select one.)

- ☐ 18-29
- ☐ 30-39
- ☐ 40-49
- ☐ 50-59
- ☐ 60-69
- ☐ 70+

Q19. Where is your operation located in the United States? (Select one.)

- ☐ Midwest (IA,IL,IN,KS,MI,MN,MS,ND,NE,OH,SD,WI)
- ☐ Northeast (CT,DE,MA,ME,MD,NH,NJ,NY,PA,VT,RI)
- ☐ Southeast (AL,AR,FL,GA,LA,KY,MS,NC,SC,TN,VA,WV)
- ☐ Southwest (AZ,NM,OK,TX)
- ☐ West (CA,CO,ID,MT,NV,OR,UT,WA,WY)

Q20. How many calves on your operation are currently on milk? (Select one.)

- ☐ < 80
- ☐ 80-200
- ☐ 200-500
- ☐ 500-1000
- ☐ >1000

Q21. In the last year, approximately what percent of calves on milk that arrive on your operation were: please provide a number and not ranges

Bought by you then sold back to dairy of origin _____%

Bought by you and not sold back to dairy of origin _____%

Originated from own dairy _____%

Purchased from auction market or sale barn _____%

Other, please specify _____

Q22. From how many dairies do you typically receive calves on milk? (Select one.)

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ More than 5

Q23. How did you hear about this survey?

- ☐ Convention/Meeting/Workshop
- ☐ Email

- ☐ Flyer
- ☐ Herd Veterinarian
- ☐ Online Advertisement
- ☐ Other, please specify

Q24. Which gender do you most identify with?

- ☐ Man
- ☐ Woman
- ☐ Do not identify as man or woman
- ☐ Prefer not to say

Thank you for taking this survey. To receive your $15 gift card, please provide your email. We will distribute gift cards within 3-4 weeks of participation.

_____

Would you be interested in participating in workshops, training, or research related to calf transportation?

- ☐ Yes
- ☐ No

If so, may we contact you at this email about future opportunities?

- ☐ Yes
- ☐ No

Survey of Current Dairy Industry Practices for Preweaned Calf Transportation
Calf Haulers

Colorado State University is conducting a research survey to describe current industry practices regarding the transportation of dairy or dairy x beef calves on milk in the **United States**. We want to hear from anyone making decisions about the transportation and/or receiving of dairy or dairy x beef calves on milk. That includes producers, owners, operators, or managers on dairies, calf ranches, heifer-raising facilities, and veal operations, as well as transportation drivers. Participants in the research must be over 18 years of age.

Thank you for taking the time to fill out this research survey. For each question that has a fill-in option, you are welcome to add your own selection if you feel it is not best described by one of the choices. The open-ended questions are intended for you to share your personal opinions or experiences. We anticipate the survey should take 15-20 minutes to complete.

Your responses are completely anonymous and will not be used for any purpose other than for our research. There are minimal risks to participating in this survey and you may choose to stop at any time. All responses will be summarized and reported at the aggregate level.

Thank you for taking this survey. If you have any questions about this research project, please contact:
Dr. Catie Cramer, MS, PhD (Principal Investigator)
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Dr. Sarah Depenbrock, DVM, MS, DACVIM
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Department of Medicine and Epidemiology
School of Veterinary Medicine
University of California Davis

Dr. Lily Edwards-Callaway, MS, PhD
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Colorado State University

Dr. Noa Roman-Muniz, DVM, MS
Professor and Director of Undergraduate Programs
Department of Animal Sciences
Colorado State University

If you have questions about your rights or welfare as a participant, please contact the CSU Institutional Review Board, at (970) 491-1553 or by email at CSU_IRB@mail.colostate.edu.

CONSENT TO PARTICIPATE QUESTION

- ☐ Yes, I agree that I am over 18 years of age and consent to participate in this study
- ☐ No, I do not consent to participate in this study

The main goals of this study are to better understand current industry practices for transporting calves on milk and if these practices differ between replacement heifers, dairy x beef, and dairy bull calves. We want to understand producers' challenges and needs in this area to identify research and outreach efforts.
For each question, mark your selected answer(s) or fill in the requested information.

Q1. How long have you been working as a transporter for preweaned calves? (Select one.)

- ☐ Less than 1 year
- ☐ 1 year
- ☐ 2 years
- ☐ More than 2 years

Q2. Do you receive training with specific information about transporting preweaned calves? (Select one.)

- ☐ Yes
- ☐ No

If you answer No to Q2., please proceed to Q3.

If you answer Yes to Q2., please answer Q2.1 and Q2.2

Q2.1. What type of training have you received? (Select one.)

- ☐ Trained by another employee (i.e. not a manager)
- ☐ Trained by manager
- ☐ Trained through Beef Quality Assurance Transportation (BQAT)
- ☐ Trained through Calf Care and Quality Assurance (CCQA) program
- ☐ Trained through Farmers Assuring Responsible Management (FARM) program
- ☐ Video training
- ☐ Other, please specify:_____

Q2.2. How often do you receive training for transporting preweaned calves? (Select one.)

- ☐ Weekly

- ☐ Monthly
- ☐ Yearly
- ☐ Other, please specify: _____

Q3. How many operations do you typically **pick up** preweaned calves from? (Select one.)

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ More than 5

Q4. How many operations do you typically **deliver** preweaned calves to? (Select one.)

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ More than 5

Q5. Where do you **pick up** the majority (>50%) of preweaned calves that are less than a week old? (Select one.)

- ☐ Dairy
- ☐ Cow/calf ranch
- ☐ Beef ranch
- ☐ Auction yard/Sale barn
- ☐ Veal
- ☐ Other, please specify:_____

Q6. Where do you **deliver** the majority (>50%) of preweaned calves that are less than a week old? (Select one.)

- ☐ Heifer calf raiser
- ☐ Calf ranch (raise animals for beef production)
- ☐ Auction or livestock market
- ☐ Veal
- ☐ Other, please specify:_____

Q7. Within the last year, what percentage of your preweaned calves were transported from operations? Please provide a number and not a range.

≤50 miles away: _____

51-100 miles away: _____

101-500 miles away: _____

501-1000 miles away: _____

>1000 miles away: _____

I do not know: _____

Q8. Within the last year, approximately how many calves less than 1 week of age did you transport from dairies to calf-raising facilities.

_____

Q9. What are your top **three** challenges related to calf transportation?

- ○ Distance of calf facility from dairies
- ○ Drivers incorrectly identifying which calves were picked up
- ○ Finding a buyer for calves
- ○ Labor costs/availability
- ○ Lack of employee training resources
- ○ Lack of resources (i.e. milk, housing, labor) to house calves prior to transport
- ○ Preparing calves for successful transportation (i.e. preconditioning).
- ○ Price for calves is too low
- ○ Space availability is case calf pick up is delayed
- ○ Time calves spend on the truck/trailer
- ○ Trailer conditions
- ○ Transportation logistics (i.e. distance, availability of drivers, etc.)
- ○ Other, please specify:_____

Q10: What are the top **three** resources that would be most helpful to address challenges related to calf transportation?

- ○ Best practices recommendations
- ○ Better understanding of driver turnover and/or driver schedule
- ○ Increased communication between drivers, dairies, and calf ranches
- ○ Increased premiums or sale price
- ○ Making it easier for driver to load calves onto the trailer
- ○ More options/markets for selling surplus calves
- ○ Penalties or fines for poor handling or transportation of calves
- ○ Training programs for employees
- ○ Other, please specify: _____

Q11. What is your current age? (Select one.)

- ☐ 18-29
- ☐ 30-39
- ☐ 40-49
- ☐ 50-59
- ☐ 60-69
- ☐ 70 and up

Q12. Which gender do you identify with? (Select one.)

- ☐ Man
- ☐ Woman
- ☐ Do not identify as man or woman
- ☐ Prefer not to say

Q13. What region(s) in the United States are you typically based in? (Select one.)

- ☐ Midwest (IA,IL,IN,KS,MI,MN,MS,ND,NE,OH,SD,WI)
- ☐ Northeast (CT,DE,MA,ME,MD,NH,NJ,NY,PA,VT,RI)
- ☐ Southeast (AL,AR,FL,GA,LA,KY,MS,NC,SC,TN,VA,WV)
- ☐ Southwest (AZ,NM,OK,TX)
- ☐ West (CA,CO,ID,MT,NV,OR,UT,WA,WY)

Q14. How did you hear about this survey? (Select one.)

- ☐ Convention/Meeting/Workshop
- ☐ Email
- ☐ Flyer
- ☐ Herd Veterinarian
- ☐ Online advertisement
- ☐ Other, please specify: _____

Thank you for taking this survey. To receive your $15 gift card, please provide your email. We will distribute gift cards within 3-4 weeks of participation.

_____

Would you be interested in participating in workshops, training, or research related to calf transportation?

- ☐ Yes
- ☐ No

If so, may we contact you at this email about future opportunities?

- ☐ Yes
- ☐ No