Characterizing the literature surrounding transport of young dairy calves: A scoping review protocol

H. M. Goetz[1], C. B. Winder[1], J. Dunn[1], D. F. Kelton[1], J. H. C. Costa[2], and D. L. Renaud[1]

[1]Department of Population Medicine, University of Guelph, Guelph, ON, Canada

[2]Department of Animal and Food Sciences, University of Kentucky, Lexington, KY, USA

Item 2: Structured Summary/Abstract

***Background*:**

Transport is a stressful event for cattle of all ages and can negatively impact animal health. For calves, their physiological and immune systems are still developing such that they are particularly susceptible to stressors surrounding transportation including commingling and exposure to new environments and microorganisms. This experience affects the calves in the short term but could also predispose them to lifelong challenges, such as increased risk of morbidity, mortality, and reduced average daily gain. No formal synthesis has described studies describing and evaluating the impact of transportation in young calves to date, despite its common occurrence and significant impact on calf health.

Objectives:

The objective of this scoping review is to describe and characterize the existing literature surrounding transport of young dairy calves. This review will summarize descriptive and analytic studies examining transport in young calves, including listing how the impact of transport has been assessed and evaluated, and identify knowledge gaps in literature.

Design:

All primary research will be eligible for inclusion, with the exception of case reports and case series. Study population in articles used in this review will be restricted to calves of any breed and sex from birth to 60 days of age destined for veal, dairy-beef, or dairy production. The selection and inclusion process will be reported using a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart (Moher et al., 2009). Descriptive summaries of included studies will be displayed in frequency tables and results of studies included will be

reported in summary tables and figures. This review will be reported following the PRISMA-extension for Scoping Reviews (PRISMA-ScR) (Tricco et al., 2018).

INTRODUCTION

Item 3: Rationale

Transportation poses an extreme stress for animals as they experience handling, commingling with unfamiliar animals in new environments, deprivation of food and water, and fluctuating temperatures (Trunkfield and Broom, 1990). This event is particularly challenging for young calves due to their reduced ability to thermoregulate and the occurrence of dehydration during transport (Schrama et al., 1993; Gebresenbet et al., 2012). In the context of the veal industry, all calves must be transported which creates a less effective immune system and predisposes male dairy calves to a high risk of morbidity, mortality, and reduced average daily gain during the growing period at the veal facility (Mormede et al., 1982).

The effect of transportation can be measured by evaluating behavioral indicators, hematological variables, and physiological changes in calves. Many hematological variables such as haptoglobin and creatine kinase have been documented to increase, suggesting inflammation in response to transportation (Lomborg et al., 2008; Jongman and Butler, 2014). Furthermore, a loss of up to 11% of body weight due to transport as well as suppression of average daily gain for up to 28 days after transport have been reported (Warriss, 1990; Cole et al., 1988). These short- and long-term effects highlight the impact transportation can have on not only calf health and welfare, but also the economic realities of the producers that rely on transportation.

Calf age at transportation may be a factor that has a significant influence on the success of transportation. Jongman and Butler (2014) demonstrated a difference in measurements of lying time and metabolic parameters, creatine kinase and BHB concentration, even before transportation as well as during transportation in 3-day old calves compared to 5- or 10-day old calves. Knowles (1995) also found an inverse association between age at transportation and mortality. Recent amendments to calf transport regulations in Canada state that calves 8 days or less cannot be transported unless necessary measures are taken to prevent the animal's suffering, injury, or death during loading, transport, and unloading, and their final destination is not an assembly center (Canadian Government, 2019). With these recent changes, it is important to

understand factors such as age which may affect these parameters and the calves' ability to cope with the stress of transportation.

Methods to mitigate the effect transportation has on calf health and performance have also been explored. Administration of meloxicam to Jersey calves before transportation alleviated the negative effects of transportation on milk replacer intake and average daily gain compared to calves which did not receive meloxicam (Chibisa et al., 2018). Pre-transport diet also influences calves' responses to transportation. Marcato et al. (2020) found that the increase in urea, BHB, and creatine kinase post-transport compared to pre-transport values was greater in calves that received a mixture of electrolytes dissolved in 1.5 L of water than in calves who received 1.5 L of milk at a collection center 2 hours prior to transport to the veal rearing facility.

Providing an evidence-based guideline for transportation of young calves is challenging because the effect of transportation on calves is complex. Several factors are associated with the impact of transportation such as animal characteristics, management prior to transport, loading, transport environment, climatic conditions, duration of transport, and many more (Nielsen et al., 2011). Characterizing the existing literature that surrounds the effect of transportation on calves is needed in order to make informed decisions which will ultimately improve calf health and welfare.

Item 4: Objectives

The objective of this scoping review is to describe and characterize the existing literature examining transport of young calves. This review will describe how transport has been assessed in the literature, including describing how outcomes were measured and what potential risk factors were examined. This review will also serve to identify knowledge gaps in the literature.

METHODS

Item 5: Protocol and Registration

This protocol will be archived and available in the Atrium at the University of Guelph (https://atrium.lib.uoguelph.ca/xmlui/handle/10214/10046). Deviations from the protocol will be reported in the review.

Item 6: Eligibility Criteria

Primary research studies will be eligible for inclusion in this scoping review, with the exception of case reports or case series. This will include articles describing young bovine calves younger than 60 d of age or weighing less than 100 kg of any sex with no geographical or date of publication limitations. Only articles available in English will be included in the scoping review. Articles available with titles and abstracts in English but with full texts written in another language will be enumerated in the review. Studies may either be descriptive (*i.e.* cross-sectional studies examining the prevalence of transport or other aspects of transporting young dairy calves), or analytic (observational or intervention studies). Analytic studies may be designed to examine the impact of transport on calves, using outcomes such as (but not limited to), morbidity, mortality, changes in hematological variables, changes in behavioral indicators, or effect of transport on average daily gain. They may also assess risk factors including (but not limited to) duration of transport, calf age, breed, or weight. Analytic studies may also compare interventions designed to mitigate the effects of transport, such as (but not limited to), fluid therapy or anti-inflammatory medication.

Item 7: Information Sources

A total of 8 databases will be accessed online through the University of Guelph McLaughlin library: CAB Direct (via CABI), SCOPUS, ProQuest dissertation and thesis, Agricola (via ProQuest), Medline (via Ovid), and Science Citation Index Expanded (SCI-EXPANDED), Conference Proceedings Citation Index-Science (CPCI-S), and Emerging Sources Citation Index (ESCI) (via Web of Science).

Item 8: Search

The search strategy used for this review was developed using key terms and words for preliminary broad searches and will be connected with Boolean operators. These results will be utilized to refine and format search strings for each platform and are demonstrated in Table 1.

Table 1. Results of a search to identify studies evaluating transport of calves conducted in CABI on June 24, 2020.

Number	Search Terms	Results
1	calf or calves or suckler	152, 891

2	transport or transportation or drover or truck or trailer or arrival or driving	450, 840
	1 AND 2	3, 149

Table 2. Title and author of relevant literature pre-selected by HG to validate the search strategy.

	Author & Year	Article Title	Country	Outcome
1	Staples and Haugse, 1974	Losses in young calves after transportation	USA	Morbidity, mortality
2	Mormede et al. 1982	Effect of transportation on blood serum composition, disease incidence, and production traits in young calves. Influence of the journey duration	France	Cortisol, IgG, other biochemical parameters
3	Kent and Ewbank, 1986	The effect of road transportation on the blood constituents and behavior of calves. II. One to three weeks old.	England	Hematocrit, total and differential leukocyte count, plasma corticosteroid and glucose, NEFA, total protein, calcium AST, CK, lying, rumination
4	Knowles et al. 1997	Effects on calves less than one month old of feeding or not feeding them during road transport of up to 24 hours		Cortisol, glucose, urea, NEFA, BHB, CK, total protein, albumin, osmolality, skin thickness heart rate, weight
5	Knowles et al. 1999	Effect on young calves of a one-hour feeding stop during a 19-hour road journey		Lying, standing, ambient temperature, humidity, heart rate, weight, body temperature, glucose,

				osmolality, urea, PCV, albumin, CK, NEFA
6	Cave et al. 2005	Mortalities in bobby calves associated with long distance transport	Australia	Mortality
7	Fell and Shutt, 1986	Adrenocortical response of calves to transport stress as measured by salivary cortisol.	Australia	Salivary cortisol
8	Fisher et al. 2014	The effects of direct and indirect road transport consignment in combination with feed withdrawal in young dairy calves	Australia	CK, glucose, BHB, lactate, total protein, PCV, body weight, lying behavior
9	Jongman and Butler, 2014	The effect of age, stocking density, and flooring during transport on welfare of young dairy calves in Australia	Australia	Lying during transport, lying and drinking during recovery, glucose, BHB, hydration (PCV, CK), age
10	Chibisa et al. 2018	Short communication: effects of meloxicam administration on protein metabolism and growth performance in transported Jersey calves	USA	Rectal temperature, weight, cortisol, haptoglobin, total protein, amino acids, ADG
11	Marcato et al., 2020	Effects of pretransport diet, transport duration, and type of vehicle on physiological status of young veal calves	Germany/ The Netherlands	Glucose, urea, lactate, NEFA, BHB, CK, albumin, total protein, osmolality, calcium, sodium, magnesium, body weight, rectal

				temperature, skin elasticity
12	Masmeijer et al. 2018	Randomized field trial on the effects of body weight and short transport on stress and immune variables in 2- to 4-week-old dairy calves	Belgium	Cortisol, WBC counts, serum total protein, cytokine release
13	Todd et al. 2000	Effects of food withdrawal and transport on 5- to 10-day-old calves	New Zealand	Glucose, BHB, urea, lactate, creatine phosphokinase, PCV, total protein, weight, rectal temperature
14	Uetake et al. 2011	Effects of haul distance and stocking density on young suckling calves transported in Japan	Japan	Lying, turning around, cortisol, serum total protein, fecal consistency, aspertate aminotransferase, IgM
15	Johnston and Buckland, 1976	Response of male Holstein calves from seven sires to four management stresses as measured by plasma corticoid levels	Canada	Plasma corticoid level
16	Grigor et al. 2001	Effects of space allowance during transport and duration of mid-journey lairage period on the physiological, behavioural and immunological responses of young calves during and after transport		Lying, cortisol

17	Bernardini et al., 2012	The effects of different environmental conditions on thermoregulation and clinical and hematological variables in long-distance road-transported calves	Italy	Rectal temperature, body weight, heart rate, hematocrit, RBC, WBC, differential leukocyte counts, cortisol, glucose, BHB, NEFA, urea, lactate, CK, lactate dehydrogenase, aspartate aminotransferase, Ca, P, Mg, Na, Cl, K, total protein
18	Bernardini et al., 2011	Effects of ambient temperature on calf welfare parameters during long-road transportation	Italy	Rectal temperature, body weight, ambient relative humidity, ambient temperature, subcutaneous temperatures, heart rate
19	Cockram and Spence, 2012	The effects of driving events on the stability and resting behaviour of cattle, young calves and pigs		Driving events, lying, stability, falling

Item 9: Selection of sources of evidence

In the first level of screening, two reviewers will assess the title, abstract, and index terms of the literature identified using the search terms. The first 100 articles will be pre-tested to ensure both reviewers answer questions consistently. Articles will be reviewed independently using a list of questions and record “yes,” “no,” or “unclear” for all 3 questions. Disagreement at the form level at this stage of screening will be resolved by consensus or mediation by DLR or CBW if consensus cannot be reached. Articles receiving “yes” or “unclear” to all 3 questions will be

included in the second level of screening. The questions that will be answered for each article include:

1. Is the title/abstract in English?
2. Does the title/abstract identify a primary research article (not a case report or case series)?
3. Does the title/abstract describe transport of young calves (less than 60 days of age, or 100kg)?

Following the first level of screening, all articles that moved into the second level of screening will have their full texts retrieved using citations where they will be saved as a PDF and uploaded into DistillerSR® and are titled their respective refID number. In the second level of screening, two independent reviewers will assess each full-text article for eligibility in the study. The second level of screening will use a list of questions that can only be answered by "yes" (neutral) or "no" (exclude). Any disagreement on this level will be resolved by consensus. If the conflict persists, there will be a third-party intervention. The first 20 articles will be pre-tested to ensure reviewers understand the questions. Any exclusions will be documented. The list of questions is as follows:

1. Is the full text article available in English? "yes" (neutral), "no" (exclude, submit form)
2. Does the full text article investigate or describe transport of calves under 60 d of age or less than 100 kg? "yes" (neutral), "no" (exclude, submit form)
3. Does the full text article describe a primary research study? "yes, descriptive" (include), "yes, analytic observational" (include), "yes, controlled trial" (include), "no" (exclude)

Item 10: Data charting process

The selection and inclusion process will be reported following PRISMA (Moher et al., 2009). Summaries of included studies will be compiled in frequency tables to describe study characteristics and target populations. Summary tables and figures will be used to report the results of studies included.

Item 11: Data items

Data Management

The results from the search will be uploaded into EndNote (Clairvate Analytics, Philadelphia, USA) reference management software and will be de-duplicated. The references included in the review will be imported into DistillerSR® (Evidence Partners Inc., Ottawa, Canada) where further duplicates will be removed, studies will be screened, and data extraction is completed.

Data Extraction

Two reviewers will independently extract data from the included full-text studies using a structured pre-tested form created in the review management program DistillerSR®. Both reviewers will conduct a pilot test of 5 references in order to ensure consistency and understanding. Any disagreement on this level will be resolved by consensus. If the conflict persists, there will be a third-party intervention. Authors will not be contacted to request missing data or to clarify published results. Data extraction will be completed using structured pre-tested forms created in DistillerSR® that will include:

Study level characteristics (for all studies):

- publication year
- year of study conduct
- location of study

Study population (for all studies):

- number of farms included
- sample size
- farm type/production system
- breed
- calf age at enrollment (if applicable)
- calf sex

For descriptive studies:

- Study objectives
- Text box to describe how transport was measured
- Text box to describe results relating to transport

For analytic observational studies:

- Study objectives
- Study hypothesis
- Outcomes assessed (relating to transport)
    - Case definition
    - Time at risk
- Assessment of transport related risk factors (exposure)
    - Transport - binary (yes/no)
    - Transport - continuous (time, duration, etc.)
    - Transport – other (quality, type of truck, etc.)
- Assessment of other risk factors
    - Case definition
    - Time at risk

For intervention studies (controlled trials):

- Study objectives
- Study hypothesis
- Interventions assessed
    - full description of each treatment group
- List of outcome assessed
    - Case definition
    - Time at risk
- Covariates explored or measured
    - List these

Item 14: Synthesis of Results

A descriptive analysis of study characteristics (publication date, geographical region), target population, sample size, and study approach. The results from this analysis will be recorded in a table. The table will include the definition of transport, the definition of morbidity, and any health parameters evaluated, in addition to general findings. To report the results, summary figures and tables will be used. A map will be used to demonstrate the scope of geographical areas where eligible studies were conducted. A histogram will be used to demonstrate the total number of eligible studies published by year.

RESULTS

Item 17: Selection of source of evidence

The study inclusion process will be demonstrated using a PRISMA flow chart (Moher et al., 2009), including the total number of screened studies, excluded studies, and reason for exclusion. To allow for replication of the search, the full search strategy will be included in a summary table.

Item 18: Characteristics of sources of evidence

Study characteristics will be displayed in tables to record information such as date of publication, geographical region, target population, sample size, and study design.

Item 20: Results of individual sources of evidence

The nature of how transport has been measured and assessed will be reported, as well, a full description of all outcome measures and potential risk factors will be reported. Details on study methodology will also be described.

DISCUSSION

Item 24: Summary of evidence

This scoping review will allow for a compilation of primary research assessing the impact of transport on young calves. The results acquired from this scoping review will help identify knowledge gaps in current literature and direct research in a way that will support improvement of calf health and welfare in the industry.

Item 25: Limitations

The literature available for this review is likely scarce, therefore, excluding studies that are not in English may remove data that otherwise fits the eligibility criteria. Additional limitations at the review level will be discussed.

Item 26: Conclusions

This review will describe primary research describing or examining the effect of transport on young calves. These results will allow for a better understanding of the current knowledge in this field, identify gaps in literature, and inform future studies. In order to set evidence-based guidelines for calf transportation, an understanding of the body of literature is needed to inform stakeholders.

Item 27: Funding

This scoping review is part of a larger project evaluating the effect of age at transport from dairy farms to veal facility on calf health and performance at the veal facility. The funding for this study and this review was provided by Veal Farmers of Ontario, Dairy Farmers of Canada, and the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA).

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