Investigation of Prognostic Factors Associated with Diagnosis, Treatment and Rehabilitation of Non-ambulatory Dairy Cattle: Protocol for a Scoping Review

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Abstract

Background: Downer cow syndrome is a condition in which dairy cattle become unable to stand. This condition poses severe welfare concerns regarding handling of these animals, as well as financial losses associated with treatment, halted milk production and culling. There are several factors that contribute to cattle succumbing to a non-ambulatory state. These include metabolic imbalances and environmental factors related to housing and management. There is little consensus among both veterinarians and dairy producers on how to manage and care for down cattle, leading to wide variation in the level of care these animals receive. This may stem from the limited amount of scientific literature available to veterinarians and dairy farmers to help inform decisions around diagnosis and treatment of non-ambulatory dairy cattle. A qualitative synthesis of information regarding diagnosis, treatment and rehabilitation of non-ambulatory dairy cattle has the potential to guide further research into downer cow syndrome, helping to reduce the associated financial and welfare concerns.

Objectives: The objective of this scoping review is to characterize the body of literature investigating prognostic factors associated with diagnosis, treatment and rehabilitation of non-ambulatory dairy cattle.

Design: Six databases will be searched for relevant primary literature. Literature will be included if the population being studied consists of mature dairy cows. The screening process of this scoping review will be described via a flowchart described by Liberati et al. (2009) as per the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA). The PRISMA extension for scoping reviews will be used as a framework to guide the reporting of this scoping review (Tricco et al., 2018).

Introduction

Non-ambulatory cattle represent an important welfare concern and financial loss for dairy producers, with approximately 450,000 cattle reported as non-ambulatory annually in the Unites States, and over 20,000 dairy producers reporting at least one down animal over a one year period (NASS, 2005). Although national statistics regarding non ambulatory cattle do not currently exist in Canada, the proportions can be expected to be similar to that of the United States due to similar housing and management practices. The condition of cattle becoming non-ambulatory is often referred to as “Downer cow syndrome” (Fenwick, 1969), and can be defined as cattle that are unable or unwilling to stand (Fenwick, 1969; Cox, 1988) and remain recumbent for $\geq$ 12 h (Burton et al., 2009). This recumbent state can lead to financial losses for

the producer due to costs associated with provision of veterinary care and ceased milk production due to sternal recumbency.

Additionally, non-ambulatory cattle pose a variety of animal welfare concerns: the reason the animal is non-ambulatory could be a source of pain, such as severe lameness; these animals are often unable to eat and drink on their own and require diligent care; the longer an animal remains recumbent, the greater their risk of developing secondary muscle injury, which is an additional source of pain; lastly, inappropriate movement of down cattle can lead to severe injury and in some cases may constitute animal abuse. Improper handling of non-ambulatory cattle could potentially violate the *Health of Animals Act* (S.C. 1990, c. 21), which prohibits loading or transport of infirm animals in a way that leads to undue suffering. Doonan et al. (2003) explored the fallacy of economic pressure driving producers to transport downed dairy cattle for slaughter, highlighting that the cost of loading, shipping and potential fines outweighs any financial return that could be garnered as the majority of these animals end up being condemned at the slaughter plant.

The Dairy Farmers of Ontario *ProAction* Animal Care Program requires dairy producers to develop a corrective action plan that lists how they plan to manage and care for non-ambulatory cattle (Dairy Farmers of Canada, 2019). While this issue is of high importance, there is a lack of consensus among both dairy producers and veterinarians on how to best care for and manage non-ambulatory cattle (Doonan et al., 2003).

The current observational research into factors associated with risk (Green et al., 2008; Correa et al., 1993), recovery (Burton et al., 2009; Stojkov et al., 2016), prevention and welfare (Stull et al., 2007) of non-ambulatory cattle is very limited, and extrapolation of these results to different housing and management practices may not be appropriate. There is currently no formal synthesis of literature regarding management and care of down cattle besides narrative reviews, which have the potential for biased conclusions (Sargeant and O'Connor, 2014). As a consequence of the lack of formal synthesis of information, decisions regarding management and care of non-ambulatory dairy cattle are currently based on the experience of the producer and advice from their veterinarians, which may be informed by their clinical experience, formal education, continuing education, or a host of other internal and external factors (Boxelaar and Paine, 2005). We believe that this decision-making paradigm may result in wide variation in the care received by non-ambulatory cattle.

There is a clear need to provide evidence-based information to veterinarians and dairy farmers to allow them to make informed decisions with respect to down cattle. Formal synthesis of this information has the potential to guide future research into prognostic factors associated with non-ambulatory cattle, improving the welfare of thousands of animals and improving the sustainability and social license of the dairy industry as a whole.

Objectives

The objective of this scoping review is to characterize the body of literature investigating prognostic factors associated with diagnosis, treatment and rehabilitation (or lack thereof) of non-ambulatory dairy cattle; with the intent of qualitatively synthesizing knowledge of the topic and to identify gaps in the literature.

Methods

Protocol and registration

This protocol will be archived and available online in the Atrium at the University of Guelph (https://atrium.lib.uoguelph.ca/)

Eligibility Criteria

This scoping review will include only primary literature and conference proceedings which describe an analytical study of a population of mature dairy cattle of any dairy breed experiencing recumbency. Only studies published in English will be included. There will be no restrictions regarding geography or date of publication, aside from that of the databases searched.

Information Sources

A literature search will be conducted in the following databases: AGRICOLA (via ProQuest), SCI-EXPANDED (via Web of Science), CPCI-S (via Web of Science), ESCI (via Web of Science), SCOPUS, CAB Direct (via CABI), Medline (via Ovid) and ProQuest Theses and Dissertations (via ProQuest). Conference proceedings will be accessed from the World Buiatrics Congress (conference proceedings from 2002 to 2018 available online via the IVIS website) and the website for the American Association of Bovine Practitioners (conference proceedings from 2013 to 2018 available via the AABP website).

Search

A preliminary investigation of potential search terms was conducted in CAB Direct (via CABI) **Table 1** shows the results of the initial search.

#	Search Terms	Number of Results
1	(Non-Ambulatory OR “non ambulatory” OR ambulatory OR downer OR recumbent OR recumbency OR Immobile OR “Unable to stand” OR “Unwilling to stand” OR paralysis OR paralyzed)	35,835
2	(Cow* OR Bovine OR Cattle OR “Bos Taurus” OR Bovinae OR Heifer*)	797,789
3	("down cow" OR "down cattle" OR "down bovine" or "down animal" or "down heifer")	57
4	(1 AND 2) OR 3	3,323

Table 1: Preliminary testing of search string conducted in the database CAB Direct (via CABI) on December 13th 2019 at 6:00 PM.

Data Management

Results from database searches will be uploaded into EndNote (Clairvate Analytics, Philadelphia, USA) reference management software where they will be deduplicated. References will then be uploaded into DistillerSR (Evidence Partners Inc., Ottawa Canada) for screening and data extraction after an additional check for duplicate studies.

Selection of Evidence

The screening process of this scoping review will occur in two phases, each completed independently by two reviewers.

Phase 1

The articles resulting from each search string described above will be screened in duplicate by two reviewers based on answers to the three questions listed below. Each reviewer will answer "yes", "no", or "unclear" to each of the questions below. For an article to pass phase 1 of the screening process, it must receive an answer of "yes" or "unclear" for all three of the questions, while an answer of "no" for any of the three questions will result in exclusion. Pre-testing will be done on the first 100 records to ensure clarity of the form. Disagreements between reviewers at the form level will be resolved by consensus, with mediation by the other authors if consensus cannot be reached.

1. Is the title/abstract available in English? Yes (neutral), Unclear (neutral), No (Exclude, submit form)
2. Does the title/abstract describe primary research? Yes (neutral), Unclear (neutral), No (Exclude, submit form)
3. Does the title/abstract describe a study involving dairy cattle that are unable to stand? Yes (include), unclear (include), no (exclude, submit form)

Phase 2

The full text of articles which passed phase 1 will be obtained and subjected to a second phase of screening. In this phase, the questions listed below will be answered in duplicate by two reviewers and reasons for exclusion of full text articles will be reported. Conflicts will be resolved through mediation by DLR or CBW if consensus cannot be reached. Pre-testing will be done on the first 10 records to ensure clarity of the form.

1. Does the full text describe primary research? Yes (neutral), No (Exclude, submit form)
2. Is the full text available in English? Yes (neutral), No (Exclude, submit form)
3. Is the full text >500 words? Yes (neutral), No (exclude, submit form)
4. Does the full text describe a study involving dairy cattle that are unable to stand? Yes (neutral), no (exclude, submit form)
5. Does the full text describe an analytical study? Yes, RCT (include), Yes, analytic observational (include), No, descriptive observational (exclude), No, case report/case series (exclude)

Data Extraction

Data extraction will be performed in duplicate by two reviewers, with conflicts resolved by consensus, with mediation by DLR or CBW if needed. The data extraction of the first 10 articles will be pre-tested to ensure clarity and consistency. Data extraction will include:

1: General Information
- 1.1: Publication year
- 1.2: Year study was conducted
- 1.3: Country in which the study was conducted

2: Study Information
- 2.1: Hypothesis of the study
- 2.2: Objective(s) of the study
- 2.3: Target population
- 2.4: Source population
- 2.5: Sample size

3: Population attributes
- 3.1: Unit of concern (Farm, cow, other)
  - 3.1.1: Farm level characteristics (text box)
  - 3.1.2: Cow level characteristics:
    - 3.1.2.1: Breed of dairy cow
    - 3.1.2.2: Housing type (tie/free/pasture)
    - 3.1.2.3: Flooring type
    - 3.1.2.4: Age range of animals
    - 3.1.2.5: Mean age of animals
    - 3.1.2.6: Calcium supplementation status
    - 3.1.2.7: Average pregnancy status of animals (post calving)
  - 3.1.3: Other (Please Specify):

4: Study approach
- 4.1: Randomized Control Trial
  - 4.1.1: Type of RCT (parallel, crossover, factorial, cluster, split plot)
  - 4.1.2: Unit of Concern
  - 4.1.3: Randomization strategy
  - 4.1.4: Allocation strategy
  - 4.1.5: Type of control (Historical/concurrent/positive/negative)
  - 4.1.6: Description of Intervention:

4.1.7: Outcome
4.1.7.1: Case Definition
4.1.7.2: Period at Risk

4.2: Cross sectional Studies
4.2.1: Description of Exposure:

4.2.2: Outcome
4.2.2.1: Case Definition
4.2.2.2: Period at risk
4.2.3: Longitudinal?

4.3: Cohort Studies
4.3.1: Prospective or Retrospective
4.3.2: Description of Exposure:
4.3.3: Outcome
4.3.3.1: Case Definition
4.3.3.2: Period at Risk

4.4: Case Control Studies
4.4.1: Prospective or retrospective
4.4.2: What are cases
4.4.2.1: Case Definition
4.4.2.2: Period at Risk

4.4.3: What are controls
4.4.3.1: How defined/Recruited

Data Reporting

Charting

The charting and reporting of data will be adapted from the chart format developed by Liberati et al. (2009). This will consist of a frequency table which will summarize the data contained within each selected study. The PRISMA-extension for scoping reviews will be used as a framework for this scoping review (Tricco et al., 2018).

Synthesis of Results

Tables will be used to record descriptive statistics such as date and country of publication, sample size, and type of analytical study used. Qualitative aspects of studies such as type of treatment, farm characteristics, and description of recumbent cattle will also be tabulated. General conclusions from the study will be included, along with necessary figures.

Selection of Sources of Evidence

The selection of source evidence will follow the framework of the methodology flowchart described by Liberati et al. (2009). This flowchart will be included in the present scoping review, providing an opportunity to illustrate how many studies were included and excluded at each stage of the screening process. The full search strategy for at least one database will be included in a table.

Characteristics of Sources of Evidence

Descriptive analysis of study characteristics such as date and country of publication, sample size and study approach will be recorded using tables.

Results of Individual Sources of Evidence

The aim of this scoping review is to characterize the literature regarding down cattle, we will report any provided statistics given that they relate to the prevalence, risk, diagnosis, treatment or recovery of non-ambulatory cattle.

Limitations

Limitations will be discussed at the study and review level.

Discussion

This scoping review will summarize the current literature regarding prognostic factors associated with diagnosis, treatment and rehabilitation of non-ambulatory dairy cattle. This will allow identification of gaps in the literature which will guide future research into the topic, improving the welfare of dairy cattle and benefiting the dairy industry by decreasing financial losses and increasing social license.

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