Preventive Veterinary Medicine 122 (2015) 280–286

Contents lists available at ScienceDirect

Preventive Veterinary Medicine

journal homepage: www.elsevier.com/locate/prevetmed

Creating a model to detect dairy cattle farms with poor welfare using a national database

C. Krug[a,*], M.J. Haskell[b], T. Nunes[a], G. Stilwell[a]

[a] Centro de Investigação Interdisciplinar em Sanidade Animal, Faculdade de Medicina Veterinária, Universidade de Lisboa, 1300-477 Lisboa, Portugal
[b] Scotland's Rural College, EH9 3JG Edinburgh, UK

ARTICLE INFO

Article history:
Received 4 February 2015
Received in revised form 21 October 2015
Accepted 22 October 2015

Keywords:
Dairy cattle
Animal welfare
Welfare Quality
National cattle database

ABSTRACT

The objective of this study was to determine whether dairy farms with poor cow welfare could be identified using a national database for bovine identification and registration that monitors cattle deaths and movements. The welfare of dairy cattle was assessed using the Welfare Quality® protocol (WQ) on 24 Portuguese dairy farms and on 1930 animals. Five farms were classified as having poor welfare and the other 19 were classified as having good welfare. Fourteen million records from the national cattle database were analysed to identify potential welfare indicators for dairy farms. Fifteen potential national welfare indicators were calculated based on that database, and the link between the results on the WQ evaluation and the national cattle database was made using the identification code of each farm. Within the potential national welfare indicators, only two were significantly different between farms with good welfare and poor welfare, 'proportion of on-farm deaths' ($p < 0.01$) and 'female/male birth ratio' ($p < 0.05$). To determine whether the database welfare indicators could be used to distinguish farms with good welfare from farms with poor welfare, we created a model using the classifier J48 of Waikato Environment for Knowledge Analysis. The model was a decision tree based on two variables, 'proportion of on-farm deaths' and 'calving-to-calving interval', and it was able to correctly identify 70% and 79% of the farms classified as having poor and good welfare, respectively. The national cattle database analysis could be useful in helping official veterinary services in detecting farms that have poor welfare and also in determining which welfare indicators are poor on each particular farm.

1. Introduction

In the last 50 years, the main goal of dairy farming has been to increase milk production through genetic selection and management, thereby increasing farm profit and reducing cost for consumers. However, this one-sided selection for increased yield has brought, along with other issues, lower ability to reproduce, higher incidence of several production diseases, decreased longevity and modification of normal behaviour, which may contribute to a decline in the welfare of dairy cows (Oltenacu and Broom, 2010).

Consumer demands are the most important drivers of change in breeding and management practices, and although there has been a growing body of legislation on animal welfare within the European Union, there are only a few member states that have specific legislation on adult dairy cattle (e.g. Denmark, Austria, Sweden; European Commission, 2015). Therefore, scientific attention has been drawn to finding practical, accurate and measurable indicators of animal welfare for use on dairy cattle farms. To this end, various on-farm welfare assessment protocols have been developed. Most recently, the European Welfare Quality® (WQ) project developed protocols for dairy cattle and for other domestic species that resulted in reliable on-farm monitoring systems. The WQ assessment protocol for dairy cows includes 30 measures, 12 criteria and four principles (good feeding, good health, good housing and appropriate behaviour) that contribute to the final classification of a dairy farm. In contrast to previous protocols that focused mainly on resource-based measures (Sørensen et al., 2001; Main et al., 2007; Calamari and Bertoni, 2009), the WQ protocols focus mainly on animal-based measures, or outcome measures, which reflect the interaction between the animal and its environment (Veissier, 2007). However, application of the WQ protocol is time-consuming and expensive and there are concerns about whether it

* Corresponding author at: Faculté de Médecine Vétérinaire, Université de Montréal, C.P. 5000 Saint-Hyacinthe, Québec J2S 7C6, Canada.
E-mail addresses: catarina.de.noronha.krug.marques.da.sil@umontreal.ca, denoronhakrug@hotmail.com (C. Krug).

http://dx.doi.org/10.1016/j.prevetmed.2015.10.014
0167-5877/

can feasibly be implemented in all farms (Knierim and Winckler, 2009).

The welfare of cattle on dairy farms is generally assessed for two main reasons: for quality assurance or for detection of poor welfare conditions. For the former, all farms should be evaluated but for the latter, reducing the number of farms that must be inspected by using a system that identifies a smaller sample of 'at risk' farms from pre-existing data from national cattle databases, would be advantageous.

National herd identification and registration databases for cattle contain a list of records that have become more comprehensive since the Bovine Spongiform Encephalopathy crisis, and that have the potential to be part of the future welfare monitoring systems (Fraser, 2004; European Food Safety Authority, 2012). To our knowledge, only three studies have explored the use of databases to identify dairy herds with poor or good welfare (Sandgren et al., 2009; Nyman et al., 2011 de Vries et al., 2014). Sandgren et al. (2009) and Nyman et al. (2011) used the same data set to detect dairy herds with poor and good welfare, respectively, but they used only nine animal-based measures to assess welfare at farm level. De Vries et al. (2014) employed a larger data set and the WQ protocol to assess welfare at farm level, then used the potential welfare indicators to predict specific WQ measures (e.g. severely lame cows, avoidance distance, very lean cows).

In the current study the objective was to identify routinely collected records from the national cattle database that would allow to predict the overall welfare at the farm level. These indicators could then be used to facilitate the identification of farms for which a complete WQ audit is necessary (i.e. those with a relatively high probability of insufficient welfare).

2. Materials and methods

2.1. Farms, animals and the welfare quality® protocol

Data from 24 dairy herds were included in this cross-sectional study. The convenience-based selection of farms was done by using contacts that had already been established for another study on culling strategies (for which farms were selected because they had reliable and available records; (Barros, 2013) or through veterinary practitioners. Thirteen of these farms were located in the centre of Portugal and 11 were located in the north of the country. Holstein–Friesian was the predominant cow breed. All farms used free-stalls with the exception of one, which was based on an open bedded system. Two of the herds had 400–680 milking cows, seven had 200–399, nine had 100–199 and six had 20–99 milking cows. A total of 1930 cows were assessed. Each farm was visited once between January 2013 and March 2013 by the first author (CK), spending an average of one day per farm.

The WQ assessment protocol for dairy cattle was conducted (Welfare Quality®, 2009). The protocol consists of 30 measures that cover four principles—health, feeding, housing and behaviour. The sample size of cows on each farm was selected according to the WQ protocol, being determined by herd size. As suggested by the WQ protocol, cows in each farm were selected randomly, in the milking parlour. In the case of one farm that had a robotic milking system, animals were selected in the feeding rack, choosing every nth cow in the rows. No dry cows, or animals housed away from the milking herd were included.

Data collected on farm (30 welfare measures) were used to calculate scores for the 12 animal welfare criteria, which in turn were used to score the four welfare principles—Good feeding, Good health, Good housing and Appropriate behaviour (Table 1)—and these contribute to the final welfare classification of a dairy farm. Each farm has four possible classifications: excellent, enhanced, acceptable and not classified (poor). To be assigned to one of these levels of welfare, a farm must reach the assigned value for that particular classification (≥75 for excellent, ≥50 for enhanced, ≥15 for acceptable) on 2 or 3 of the 4 principles, and not score below that value for the lowest category on the other principle(s). For example, if a farm has an excellent classification in two principles, and the other two are acceptable, the farm is considered enhanced (Welfare Quality®, 2009).

Table 1
Welfare principles, criteria and indicators of Welfare Quality® protocol for dairy cattle (Welfare Quality®, 2009).

Principles	Welfare criteria	Welfare measures
Good feeding	Absence of prolonged hunger	Very lean cows
	Absence of prolonged thirst	Water points conditions
Good housing	Comfort around resting	Lying behavior; dirtiness
	Thermal comfort	As yet, no indicator is developed
	Ease of movement	Presence of tethering
Good health	Absence of injuries	Lameness; integument alterations
	Absence of disease	Cough; nasal discharge; ocular discharge; vulvar discharge; diarrhea; hampered respiration; subclinical mastitis; on-farm mortality; dystocia; and downer cows
	Absence of pain induced by management procedures	Disbudding/dehorning and tail docking
Appropriate behaviour	Expression of social behaviours	Agonistic encounters
	Expression of other behaviours	Access to pasture
	Good human animal relationship	Avoidance distance
	Positive emotional state	Scores of 20 terms of the qualitative behaviour assessment

In our project, only one of the 24 farms was scored as having enhanced welfare, while the majority (18 farms) was scored as acceptable and five farms were considered not classified because they did not reach the minimum requirements. Following this classification the farms were divided into two groups: farms scored 'enhanced' or 'acceptable' ($n = 19$) were classified as having 'good welfare' (GW) and farms with score 'not classified' ($n = 5$) were categorized as having 'poor welfare' (PW).

2.2. Potential welfare indicators from national cattle database

A subset of data concerning the time between January 2008 and December 2011 was extracted from the Portuguese national cattle database (Sistema Nacional de Identificação e Registo de Bovinos, SNIRB), with the exception of animal movements for which data until October 2012 were available. The data subset included the following tables: live cattle; births; herd movement records; and records at slaughter. From these tables, that contained a total of 14,558,563 records, variables for analysis were generated (see Table 2 for calculations). Variables were selected based on a literature review on animal welfare (Fraser and Broom, 1990; European Food Safety Authority, 2006), on potential welfare indicators already identified by Sandgren et al. (2009) and on the data that were available in the national database. The variables calculated were: median age at first calving (AFC); proportion of calving intervals lower than the biologically acceptable (CCI < 345); proportion of calving intervals higher than 430 days (CCI > 430); calf mortality rate (until six months; MtC); mortality rate (Mt); proportion of on-farm deaths (OFD); proportion of emergency slaughter (EmgSl); median total life span (TLS); proportion of cows slaughtered before 30 days post-partum (30ppSl); proportion of cows slaughtered