

# The use of alternative data sources to design targeted surveillance of on-farm cattle welfare

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## Abstract

We attempt in this study to test the use of calf mortality as a welfare indicator of on-farm welfare. Random programmed visits in the UK conducted by the State Veterinary Service of the Department of Environment, Food and Rural Affairs (DEFRA) could be better targeted to calf enterprises at risk of having poor welfare. Calf mortality data were retrieved from the Cattle Tracing System (CTS) in three UK counties to estimate calf mortality rates at holding and county level. A selection criterion based on upper quartiles of calf mortality for the county of concern has been defined. Finally its predictive ability of the overall welfare grade was calculated from an “ad-hoc” field study conducted in a selected sub-population. The average calf mortality rates 2002 and first half of 2003 in Inverness was 0.0178 deaths/180 calf-days and a death risk of 1.76%, in 0.0601 deaths/180 calf-days and a death risk of 5.83% in Cheshire and 0.0492 deaths/180 calf-days with a death risk of 4.8% in Norfolk. The positive predictive value of the model is 26.92% and the negative predictive value is 65.38%. The area under the ROC curve is 0.5451. The reasonable negative predictive value of the diagnostic tool gives us sufficient confidence to discard holdings that are not in the upper quartile for targeted surveillance of on-farm welfare, using the current model of welfare inspections implemented in Great Britain.

## Introduction

In 2004 the State Veterinary Service (SVS) of the Department of Environment, Food and Rural Affairs (DEFRA) in Great Britain carried out a total of 16,788 welfare assessments at 2,214 visits of calf, dairy and beef enterprises, either randomly selected (472 inspections) or targeted (1,742 inspections). An overall welfare grade is assigned to each inspected enterprise based on the compliance with The Welfare of Farmed Animals (England) (Scotland) (Wales) (Northern Ireland) Regulations 2000 and the Code of Recommendations for the Welfare of Livestock, DEFRA 2003. Eleven sections are included in the welfare inspection report: staffing, inspection, disease treatment, records, housing, environment, equipment, freedom of movement, feed and water, mutilations and breeding procedures.

The Cattle Tracing System (CTS) is part of the system of cattle identification and registration in Great Britain. It is the most comprehensive database for the cattle population in England, Scotland and Wales, recording the statutory notification of birth, death and movements of all cattle.

Morbidity and mortality rates are useful to assess poor welfare associated with disease and lack of care, together with illnesses associated to different management systems, abnormal behaviour, performance data, physiological parameters, etc. We attempt in this study to test the use of calf mortality as a welfare indicator of on-farm welfare. If the predictive value of this tool is adequate, calf mortality at holding level could be used to design targeted surveillance of on-farm welfare. Random programmed visits could be better targeted to calf enterprises at risk of having poor welfare. If so, a more effective use of the scarce human resources at the State Veterinary Services (SVS) could be achieved.

For this purpose, calf mortality data were retrieved from the Cattle Tracing System (CTS) in three UK counties to estimate calf mortality rates at holding and county level. A selection criterion based on upper quartiles of calf mortality for the county of concern will be defined. Finally its predictive ability of the overall welfare grade will be tested by statistical analyses with data obtained from routine welfare inspections and from an “ad-hoc” field study conducted in a selected population.

## Material and methods

Data were retrieved from the Cattle Tracing System (CTS) for three UK counties: Cheshire, Norfolk and Inverness during 2002 and the first half of 2003. The estimation of the calf mortality rate was calculated by the number of deaths per total number of calf-time (days) at risk. Mortality rates were calculated per 180 calf-days as this is the maximum period a calf can be at risk of death. CTS data were retrieved from three counties in the UK (Norfolk, Cheshire and Inverness) for 2002 and the first half of 2003.

For each holding, the following estimates were calculated: total number of calf-days, total number of registered dead calves and the incidence calf mortality rate for the two time periods. For each county, the following general estimates were calculated: total number of locations and holdings, average incidence calf mortality rate/180 days with 95% CI, death risk (probability of death for a calf under six months) and the distribution of locations by mortality rate, total number of calf-days and death counts. Holdings were classified applying a selection criterion based on the upper quartiles of the distribution in each county of: calf mortality rate, total number of calf-days on farm per year and death counts.

A convenience sample of 60 was randomly drawn from the list of holdings used to estimate calf mortality rates and matched by parish from two groups: 30 declared positive to the selection criterion, 10 for each of the three counties of the study. The other 30 were drawn from those declared negative. Once holdings were selected, The Animal Welfare Veterinary Division (AWVD) of Defra distributed the list of holdings to the correspondent Animal Health District Offices (AHDO) requesting to conduct a welfare inspection on farm to the calf enterprise as part of the routine programmed yearly welfare inspections. The status of each holding as far as the selection criterion is concerned was not disclosed to the inspectors trying to avoid bias assessment of the welfare status. Welfare inspections using Defra’s standard procedure and score system were conducted by Veterinary Officers in their respective areas.

Positive Predictive Value (PPV) and Negative Predictive Value (NPV) of the applied criteria was obtained by fitting a logistic regression model with upper quartile as explanatory variable and different outcomes of the overall welfare grade as dependent variable. Two different outcomes were tried: “Overall welfare grade A/Overall welfare grade B or C” and “Proportion of A scores greater than the mean/Proportion of A scores smaller than the mean”. We tried a multivariate model to test differences in the classification ability with the following variables: herd type (dairy/beef), county and membership of an assurance scheme (Yes/No). The calculation of the PPV and NPV were done using formulae as described by Greiner and Gardner (2000).

## Results

In 2002, Cheshire had the largest number of holdings with registered calves, 1691. Norfolk and Inverness had similar importance, with 826 and 857 holdings respectively. Cheshire and Norfolk had similar average number of calf-days per location in 2002: 6398 and 6177 days, In Inverness the average number of calf-days in 2002 was 3226. Considering the average number of calf-days as a proxy measure of the calf herd size, Cheshire and Norfolk would have an average size of 35 calf periods during 2002. Inverness appears to have smaller herds with 18 calf-periods..

The average calf mortality rates per county in 2002 and first half of 2003 range from Inverness with the lowest rate of 0.0178 deaths/180 calf-days and a death risk of 1.76% in 2002 compared with 0.0601 deaths/180 calf-days and a death risk of 5.83% in Cheshire. Norfolk had 0.0492 deaths/180 calf-days for the same period and a death risk of 4.8%.

52 welfare inspections were conducted between October 2004 and January 2005, 26 from each group, matched by parish: 16 in 8 parishes of Cheshire, 16 in Norfolk and 20 in Inverness. Every Veterinary Officer (VO) conducted pairs of visits in the same parish so that the number of holdings inspected in each group per VO was equally distributed. The average number of calves present and inspected per holding was 56.73 (range: 1-276). 36 calf enterprises obtained overall welfare grade A (69.23%), 15 grade B (28.85%) and 1 grade C (1.92%). None obtained overall welfare grade D.

The positive predictive value of the model is 26.92% and the negative predictive value is 65.38%. The area under the ROC curve is 0.5451. The Sensitivity is 43.75% and Specificity 47.22%. If we use as true welfare status “the proportion of scores “A” is greater than the mean proportion (89%)”, the classification ability of the model does not increase, the PPV decreases to 23% (95% CI: 10.75-42.76), the NPV improves up to 76.92% (95% CI: 57.24-89.24) but the area under the ROC curve is 0.5. Sensitivity and Specificity are both 50%, misclassifying equally holdings with grade A and B/C.

Different combinations of multivariate analysis did not improve substantially the classification ability of the test. Although some differences were detected between counties, type of inspected premises and the membership to an assurance scheme, the uncertainty of the estimates and the scarcity of data make the reporting of the estimates inappropriate. As an example, the positive predictive value of a positive dairy holding without an assurance scheme in Cheshire is 38%.

## **Discussion**

This approximation for estimating calf mortality in the UK shows how cattle registration and movement data can be used for other than the purposes for which CTS was originally developed. It was not possible to estimate the number of calves born and dead unregistered and totally absent in any of the multiple-herd data systems, except in the farm book.

The primary objective of the study was to predict the presence of poor welfare in calf enterprises, defining “poor welfare” as having an overall welfare grade C (Non compliance with the legislation without unnecessary pain-unnecessary suffering) or D (Non compliance with the legislation with unnecessary pain-unnecessary suffering). The ability to discriminate holdings with overall grade “A” or “B” from those with “C” or “D” is diminished given the results of the inspections conducted in the frame of this field study. The presence of only one holding with grade C forced us to redefine the outcome of our “true welfare status”. The analysis was designed to discriminate between holdings with A grade (69.23%) and B or C (30.77%). The aggregation of B and C grades is not adequate from the enforcement and surveillance point of view since the cut off for considering good welfare (between full compliance with the legislation and non-compliance) is merged.

The conditional probability of having B or C grade in a holding in the upper quartile is low 26.92% (95% CI: 4.78-73). If we selected for targeted surveillance holdings that appear in the upper quartile, only a quarter of them should be expected to have B or C as overall welfare grade. However the conditional probability of having A grade in a holding not in the upper quartile is over 65% (95% CI: 45.71-80.9). We should expect a majority of holdings in that section of the distribution obtaining top welfare grade. If there is a significant association between being in the

upper quartile and having welfare grade B or C, we could not detect it with our sample size (OR: 0.7 p=0.549 95% CI: 0.21-2.27).

Although the study was conducted drawing a convenience sample of the study population, the results would be likely applicable to cattle holdings in general, provided that the national average calf mortality rate is within the range of the three counties of the study and the prevalence of welfare grades are similar to the general population. The selection criterion is based on 2002 data. The interpretation of the results should be based on the assumption that retrospective mortality data is a predictor of the current welfare status.

Although uncertain, the results of this study do not rule out the potential use of the criteria as a welfare indicator for the design of targeted surveillance activities. Sample size becomes critical when differences between groups are small reducing the probability of detecting differences when they really exist. Nevertheless, the reasonable negative predictive value of the diagnostic tool gives us sufficient confidence to discard holdings that are not in the upper quartile for targeted surveillance of on-farm welfare, using the current model of welfare inspections implemented in Great Britain.

## References

The Welfare of Farmed Animals (England) (Scotland) (Wales) (Northern Ireland) Regulations 2000 . © Crown Copyright March 2003 PB 7949

Greiner M., Gardner I.A. Epidemiologic issues in the validation of veterinary diagnostic tests. Preventive Veterinary Medicine 45 (2000) 3-22

Code of recommendations for the welfare of livestock: cattle. DEFRA. Available at <http://www.defra.gov.uk/animalh/welfare/farmed/cattle/> (accessed 4 November 2005)