Validation of the Nordic disease databases

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Abstract

The Nordic disease databases have been in operation for several decades, but only limited efforts has been made to validate them. In 2007 a joint Nordic project was initiated with the aim to validate each national database and to compare the data validity between countries. Validation was made by "patient chart reviews" and by using a second source of data collected on-farm. The intention to treat sick cows also affects the completeness of the records, and this was evaluated by investigating attitudes of farmers and veterinarians. The results showed that the correctness of the data was high, but that completeness was less than 100% and it varied by disease complex and country. Standardization of disease registrations is necessary for valid between country assessments, but adjustments for incompleteness can meanwhile be used. There were also differences between countries in the attitudes to treat sick cows, which also influences the comparability of disease records between countries.

Keywords: validation, database, disease, dairy.

Introduction

Systems for recording of diseases in dairy cattle have been in operation in the Nordic countries for several decades. The system in Norway (NO) started already in the mid 70'ies (Østerås *et al*., 2007), while the systems in Finland (FI), Sweden (SE) and Denmark (DK) started in 1982, 1984 and 1991, respectively (Gröhn *et al*., 1986; Emanuelson, 1988; Bartlett *et al*., 2001). A unique feature with these systems is that the data is integrated with information from the milk-recording scheme, AI activities and routine maintenance claw trimmings in a comprehensive database on the individual animal level. The main purpose of the systems is to monitor the prevalence and incidence of endemic diseases. However, the animal databases are also used for herd health activities, genetic evaluations and for research.

Originally the disease data was only used within one country, but they have increasingly been used also for across country comparisons and for the Nordic genetic evaluations. The systems have much in common, which would make comparisons across countries reasonable. The most significant aspect is that dairy farmers in all Nordic countries have very limited access to prescription drugs, such as antibiotics, without consulting a veterinarian. Moreover, the systems also involve the veterinarian, one way or the other, in the recording of diseases, even if the technical solutions differ somewhat (Figure 1).

However, formal comparisons of disease incidences, where data were analyzed based on identical inclusion / exclusion criteria and methods, found large differences in disease incidences between the Nordic countries that were difficult to explain (Valde *et al*., 2004). These differences raised concerns about data quality and comparability, and in 2007 a joint Nordic project, DAHREVA, was initiated with the aim to validate each national database and to compare the data validity between countries. The aim of this paper was to briefly summarize some major components of DAHREVA.

DAHREVA - Assessment of the validity of the dairy health recording systems in the Nordic countries

The ultimate goal of DAHREVA, financially supported by NKJ (Nordic Joint Committee for Agricultural and Food Research), was to get a better understanding of the true disease situation in Nordic dairy herds and to create a basis for quality improvement measures. The project leader was Anna-Maija Virtala (FI) and involved several project partners in each Nordic country. The project has resulted in a large number of publications - not the least one PhD-thesis focusing on locomotor disorders (Lind, 2013), one on mastitis (Wolff, 2012), one on metabolic disorders (Espetvedt, 2013) and one on reproductive disorders (Rintakoski, 2013). The project addressed several parts in the data flow from a diseased cow until a record is found in the database (Figure 2). More specifically the goals of DAHREVA were to study

1. Discrepancies between "true disease occurrence" and health records.
2. data flow from farm to the registry.
3. Attitudes of farmers and veterinarians towards treatments and using the recording systems.

Actual versus recorded diseases

This component of DAHREVA concerned the steps 3 to 9 in Figure 2, i.e. we wanted to evaluate what proportion of diseased cows that the farmers observed ended up in the database. Herds were therefore asked to record all clinical disease in their dairy cows that they observed during their normal routine work. Recording was made on a recording sheet specifically designed for the purpose, and focus was on mastitis, reproductive disorders, locomotor disorders and metabolic diseases. Herds were provided with detailed definitions of the respective disease conditions, and were also asked to identify if the case was attended by a veterinarian or not. The study was conducted during two 2-month periods during the spring and in the autumn of 2008. A random sample of 1000, 900, 800 and 400 dairy herds with ? 15 cows in DK, FI, NO and SE, respectively (representing between 8 and 25% of the herds), were asked to participate, but in the end data was available from between 105 and 179 herds per country. Data were retrieved from the national cattle databases and matched against the data recorded in the herds, and completeness, i.e. the proportion of actual disease cases that were also found in the database, was calculated.

Completeness was calculated separately for several diseases and separately for cases that were veterinary attended and not. A few examples are presented in table 1. The low completeness for locomotor disorders in Sweden can be explained by the fact that only few cases are actually attended by a veterinarian; most (mild) locomotor disorders are handled by claw trimmers. The explanation for the low completeness

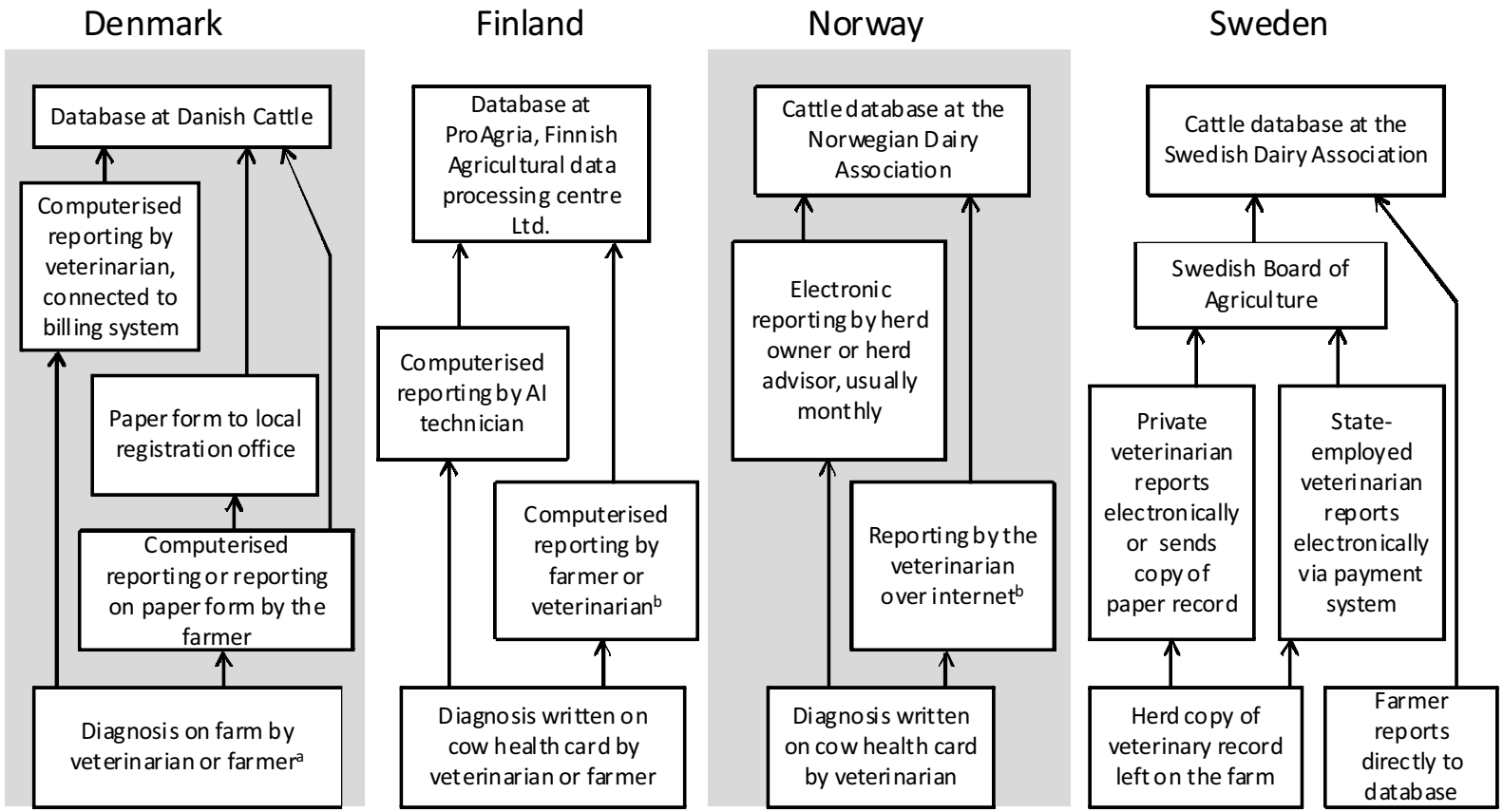

Figure 1. Data flow for disease records from the herd to the central cattle database in the four Nordic countries (Wolff, 2012).
[a]Farmers with a certain herd health contract, bIntroduced in 2008.

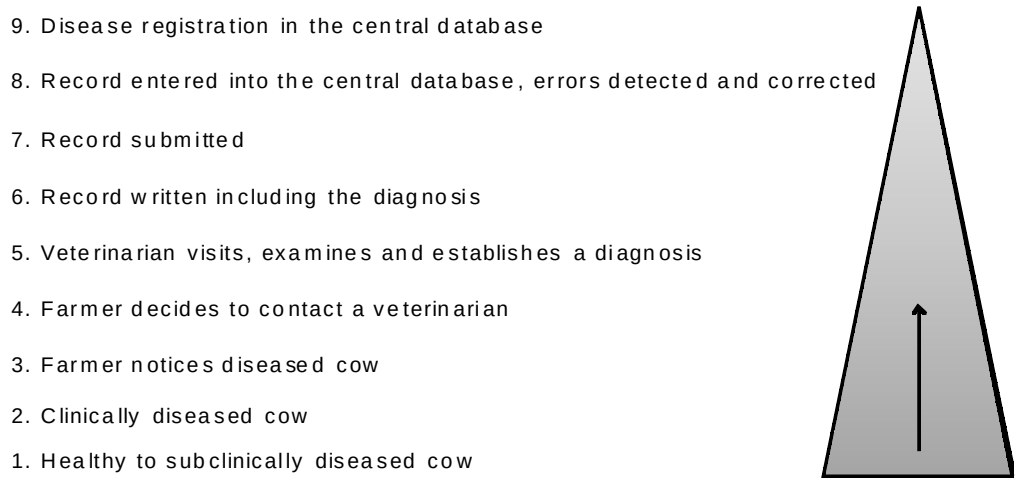

Figure 2. Data flow from a diseased cow to database (Wolff, 2012).

Table 1. Completeness for veterinary attended cases of clinical diseases observed by farmers in Denmark (DK), Finland (FI), Norway (NO) and Sweden (SE).

Disease	DK	FI	NO	SE
Locomotor disorders	0.88	0.56	0.60	0.33
Mastitis	0.94	0.56	0.82	0.78
Milk fever	0.88	0.71	0.80	0.82
Oestrus disturbances	0.96	0.93	0.85	0.85

for mastitis in Finland is that the "normal" action of a farmer at a suspected case of mastitis is to send a milk sample for bacteriological analysis and a veterinarian is usually only contacted if the sample is positive.

Completeness for all cases, i.e. both veterinary treated or not, was lower than the completeness's presented in Table 1, because cases that are not attended by a veterinarian can be reported to the database but is reported to a much lower extent. This completeness was, for example, 0.90, 0.51, 0.75 and 0.76 for mastitis, but the difference between the completeness for all and veterinary treated cases varied with disease complex. Please see publications by Lind, Rintakoski, Espetvedt and Wolff for complete results and discussions about the differences in completeness between countries and diseases.

Problems that this part of DAHREVA had to deal with were a) underreporting by the farmers; b) mismatch of dates; c) the variety of disease codes. The underreporting became obvious, because a number of disease cases that were treated by veterinarians were found in the national databases, but were still not recorded by the farmers on the recoding sheets. However, including only "good reporters", i.e. farmers with few

cases from the database not found in their recording sheets, in the calculations of completeness did not affect the results to a large extent. Many cases of diseases could not be matched between database and farm records on the exact date. This could be due to a misunderstanding of farmers in the study of what date should be reported, i.e. day of discovery of a diseased cow, day of contacting the veterinarian or day of visit of the veterinarian, or due to ambiguousness in the recording systems. Allowing for a discrepancy of ±4 (for some diseases ±7) increased the completeness significantly, but an increase to ±30 days did not increase the completeness further. Finally, we realized that there was a huge difference in the amount of disease codes used, and how specific they were, in the national databases. As an example the system used in Sweden had about 250 codes related to locomotor disorders while there were about 20 codes in each of the other countries. Also, there were 43 codes related to mastitis in Sweden, but only between 9 and 18 in the other countries. The project had therefore to create dictionaries to translate the national codes to a common code, and it is obvious that some degree of specificity was lost in that process.

The conclusion from this part of the study was that there was underreporting for all diseases in all Nordic countries and that there were significant differences in the degree of underreporting between the countries and between diseases.

Data loss

A common approach for validation of secondary data is a "patient chart review" (Emanuelson & Egenvall, 2013), and this was applied in DAHREVA to quantify the loss of data from steps 6 to 9 in Figure 2. In such an approach the on-farm records, e.g. receipts, the herd ledger, cow cards, notes in the herd-management software, etc., are compared in detail with what can be found in a database. The design of this part of DAHREVA differed between the countries, mostly due the differences that existed in procedures to record and collect the data (Figure 1). In general, treatment records on-farm was retrieved either by sending digital photos by email or sending originals or photocopies by mail services. The total number of records varied between approximately 1200 (SE) to 30,000 (DK). Completeness was calculated as the proportion of on-farm records that could be found in the database. In FI and NO also correctness, i.e. the proportion of events in the database that were correct diagnostic events, was calculated.

The average completeness was 0.80, 0.83, 0.85 and 0.84 in DK, FI, NO and SE, respectively, but the variation was substantial within country. For instance, the completeness of records made by certain kinds of veterinarians in Sweden was almost 100%, while it was lower overall. The completeness was generally affected by age of the animal (poorer for young animals), disease complex, origin of the animal (poorer for purchased animals, due to id problems) and region (at least in FI and SE). The correctness of the records in the database in Finland varied between 0.84 and 0.96 and was in Norway 0.97-9.98. Complete results and discussions can be found in the publications by Bennedsgaard, Rintakoski, Espetvedt and Wolff.

Mismatching of cow identities was a major reason for discrepancies between on-farm and database records. Part of the explanation for this problem was poor handwriting and transcription errors, but was a particular situation for cows that were not born on the farm in which case dual and ambiguous identities could give the veterinarians problems to know what to record. Another problem the project

had to deal with was again discrepancies in the dates of the recorded events. It is worth noting that also auxiliary data, such as sex, age, breed, should also be subject for assessment of correctness in studies such as these.

A conclusion from this part of DAHREVA was that information is lost in the recording process in all Nordic countries, but the degree of correctness of data that is found in the database is generally very high.

Attitudes

The third major component of DAHREVA was to evaluate attitudes towards diseases from both a farmer and a veterinary perspective, i.e. steps 3-5 in Figure 2, because the decision making process may have a significant effect on the difference between actual and recorded diseases. This part was based on the Theory of Planned Behaviour (TPB) from social psychology, where the behavioural intention (BI) is assessed rather than the actual behaviour. The BI, in turn, is determined by constructs such as a person's attitude, subjective norm and perceived control regarding the behaviour. A TBP study is very time consuming and the DAHREVA project was therefore limited to actions related to cases of mild clinical mastitis (MCM) in a lactating dairy cow. For farmers we investigated their intent to contact a veterinarian on the same day as detecting signs of MCM, and for veterinarians we investigated their intention to start medical treatment of a dairy cow with MCM on the same day as making the diagnosis. The study was a combination of face-to-face interviews and questionnaires and aimed to capture both the BI as well as the underlying constructs.

The results showed that there were significant differences in the BI of farmers between all countries except DK and NO, and that SE farmers had the weakest BI and FI farmers the strongest (Table 2). Attitude was the construct that explained most of the variability in BI in all four countries. The most important driver in all countries was to achieve a quick recovery for the cow. The BI's of veterinarians also differed between the countries (Table 2) and, assuming the intention scenarios presented to the veterinarians in this study to be equally common in the countries, the result means that the DK veterinarians would treat seven cases of MCM out of ten while veterinarians in FI would only treat four. Again, attitude was the most important component of BI in DK, NO and SE, while perceived control was most important in FI. Please see publications by Lind, Rintakoski, Espetvedt and Wolff for complete results and discussions.

Table 2. Median behavioural intention score (range 0-1) for a farmer to contact a veterinarian on the same day as detecting signs of mild clinical mastitis (MCM), and for a veterinarian to start medical treatment of a dairy cow with MCM on the same day as making the diagnosis in Denmark (DK), Finland (FI), Norway (NO) and Sweden (SE).

	DK	FI	NO	SE
Farmer	0.50	0.63	0.50	0.38
Veterinarian	0.71	0.42	0.58	0.50

The conclusion from this part of DAHREVA was that the threshold for action on signs or diagnosis of a case of mild clinical mastitis differs significantly between the countries. These differences in attitudes will also affect the proportion of cases of mastitis observed on-farm that will be recorded in the national databases, and thus also affect comparisons of disease frequencies. Similar analyses on other disease complexes are needed to be able to verify if the differences are general or specific for cases of mild clinical mastitis.

Conclusions

DAHREVA has provided a good understanding of the differences in the Nordic disease databases. It became obvious that completeness of the recordings were less than 100%, because there was underreporting and loss of data in the systems. The completeness differed between countries and between diseases; facts that can be used to adjust apparent incidences to make them more comparable between countries. The correctness of the data in the disease databases was reassuringly high. There were significant differences in attitudes towards treatments of mild clinical mastitis between the countries, which will affect comparisons of disease frequencies.

Electronic data recording and transfer is now being implemented in Finland and Norway, which may positively affect the completeness in the future. A process to harmonize disease codes between the Nordic countries has also started, partly as a result of DAHREVA, but no harmonization can ever remove differences that are due to differences in attitudes to act on observed diseases. The potential effect of differences in attitudes is important to realize for any across-country comparisons of disease frequencies.

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