TIMING AND OCCURRENCE OF FARM RECORDED DIAGNOSES IN 260 DAIRYCHAMP HERDS

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L'occurrence de 306 diagnostics possibles a été évaluée sur 103396 lactations de vaches ayant mis bas entre 1985 et 1993 dans 260 élevages utilisant le même programme informatisé de gestion de la santé. 17 diagnostics ont été enregistrés au moins une fois dans 20% des élevages étudiés. Ces 17 diagnostics représentaient 89.1% de tous les diagnostics enregistrés. L'incidence à l'échelle de la lactation a été calculée pour 10 complexes pathologiques : fièvre vitulaire, infection utérine (rétention placentaire, métrite, pyomètre, ou endométrite), mammite, cétose, dystocie, hardware disease, kystes ovariens (folliculaires ou lutéaux), boiterie, pneumonie et déplacement de la caillette. L'incidence la plus élevée concernait les infections utérines, suivies par les kystes ovariens, mammites, fièvres vitulaires, boiteries, dystocies, déplacement de la caillette, cétose, pneumonie, et hardware disease. L'incidence des pathologies dans les élevages ayant enregistré au moins un cas de la pathologie considérée était similaire aux données existantes en ce qui concerne les kystes ovariens, déplacement de la caillette, dystocie, hardware disease, boiterie, fièvre vitulaire, et pneumonie ; tandis que les taux enregistrés de cétose et de mammite étaient substantiellement inférieurs. L'incidence enregistrée d'infection utérine était substantiellement inférieure par rapport à certaines études, et supérieure par rapport à d'autres. La période de la première occurrence pour les 10 complexes pathologiques a été calculée et 12 fonctions de probabilité standard ont été ajustées aux données. Plusieurs fonctions de probabilité ajustaient les données correctement pour chaque pathologie, mais la période d'occurrence de l'ensemble des pathologies a pu être modélisée de manière adéquate par les distributions lognormale et gamma.

INTRODUCTION

Monitoring of disease occurrence in livestock operations is becoming increasingly more important. As levels of milk production continue to increase, the risk of disease has been estimated to increase (Emanuelson, 1988; Oltenacu et al, 1990; Grohn et al, 1994). Also, the economically important diseases in livestock production are now disease complexes involving dysfunction in biologic, managerial, environmental, economic, and social factors (Deluyker et al, 1991; Pritchard, 1993). These disease complexes often have high treatment costs, are often subclinical, and may continue to affect production and survival after having been "cured" (Marsh, 1986).

Numerous studies have estimated the incidence of different diseases (Cobo-Abreu et al, 1979; Erb & Martin, 1980; Dohoo et al, 1983; Grohn et al, 1986; Rowlands et al, 1986; Bigras-Poulin et al, 1990; Markusfeld, 1990; Oltenacu et al, 1990; Esslemont & Spincer, 1993; Beaudeau et al, 1994; LaPorte et al, 1994; Peeler et al, 1994); however, these studies have differed widely in their design, disease coding, and analyses. In addition, very few studies have evaluated time to first occurrence for disease (Bigras-Poulin et al, 1990) and none have attempted to mathematically model this interval.

The goal of this study was to identify the diagnoses most frequently recorded in a computerized dairy health record system and to describe the recorded rate and timing of the most frequent diseases of dairy cattle in these study farms.

MATERIALS AND METHODS

Initial data for this study was obtained from records for 296 farms participating in the University of Minnesota DairyCHAMP® Datashare program. Records from these farms were screened for diagnosis and treatment event recording and the final dataset was restricted to data for cows in their first or higher lactation from the 260 farms which recorded at least one diagnosis or treatment event. This data represented records for 103,396 cows that calved between 1985 and 1993. Analysis consisted of three separate evaluations: calculation of the frequency of recording of 306 possible diagnosis events, calculation of the incidence for the ten most common disease syndromes, and analysis of the timing of eight common disease syndromes within the lactation period.

In the first analysis, event frequencies were calculated for each of the 306 diagnoses listed in the standard dictionary of the DairyCHAMP® software[3] and then summarized in two ways: 1) the total number of events of a specific diagnosis across all farms, and 2) the proportion of the 260 farms with at least one case of the specific diagnosis. Diagnoses were then ranked from most to least frequent based on the proportion of farms with at least one case.

In the second analysis, ten disease syndromes were defined based on the diagnoses reported on more than 20% of farms in the first analysis and on disease complexes reported in previous studies. These ten disease syndromes were: milk fever, uterine infection (retained placenta, metritis, pyometra, or endometritis), mastitis, ketosis, dystocia, hardware disease, cystic ovaries (follicular or luteal cysts), lameness, pneumonia, and abomasal displacement. Disease syndromes which were likely to occur multiple times in a lactation (cystic ovaries, lameness, mastitis, and

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uterine infections) were further divided into risk categories as defined by Beaudeau et al (1994). Lactational incidence risks were calculated for each category of each syndrome as described by Erb and Martin (1980).
The third analysis evaluated the timing of occurrence of eight of the disease syndromes defined in the second analysis within the lactation period (time to first occurrence for dystocia and milk fever were not analyzed since these diseases occurred only in the first week postcalving). The median number of days from calving to first reported occurrence was calculated for each of the eight disease syndromes. Then, the timing of each disease syndrome was transformed to the number of weeks from calving to the first reported occurrence and twelve standard probability functions were then fit to the distribution of occurrence by week using the Bestfit[4] software. The twelve standard distributions tested were: the binomial, chi square, exponential, gamma, inverse gaussian, log-logistic, logistic, log-normal, normal, Pearson, Poisson, and Weibull. Goodness of fit was assessed by a chi-square analysis comparing the actual values with the values expected assuming the standard probability distribution. Chi-square values less than or equal to 1.0 ($p > 0.9999$) were considered evidence of acceptable fit.

RESULTS

The analysis of the frequency of diagnostic events identified 39,376 recorded diagnoses for the 103,396 study lactations. There were 17 diagnoses with at least one case in 20% of study farms. These 17 diagnoses represented 89.1% of the total diagnosis events recorded. Mastitis was by far the most frequent diagnosis with 18,630 events reported in 179 study farms (47.3% of all recorded diagnosis events). Uterine infection accounted for an additional 6,149 (15.6%) of the diagnostic events. Diagnoses for the ten disease syndromes in the second analysiss accounted for 33,445 (84.9%) of the 39,376 recorded diagnoses. The disease incidence was highest for uterine infections, followed by cystic ovaries, mastitis, milk fever, lameness, dystocia, displaced abomasum, ketosis, pneumonia, and hardware disease. For cystic ovaries, time to first occurrence was best described by a lognormal distribution; for displaced abomasum, ketosis, and uterine infections, by a Pearson distribution, and for hardware disease, lameness, mastitis, and pneumonia by the gamma distribution.

DISCUSSION

One of the greatest limitations to the study of risk of animal disease and their consequences on a livestock operation is the availability of sufficient quantities of reliable data. Prospective epidemiologic studies are difficult to conduct due to the excessive amount of time and expense necessary to accumulate enough data to provide adequate levels of precision. With the development of the microcomputer and sophisticated herd management software, livestock producers are generating tremendous amounts of health and performance data which has remained largely untapped. Disadvantages to conducting epidemiologic analysis with this data are two-fold: 1) there is a lack of standardized definitions for events across farms, and more importantly, 2) there are differences in the probability of recording specific events ("recording probability") across farms. An extreme example of the recording probability problem is the issue of "recording failure". For farm-generated data, it is impossible to distinguish whether a farm with no reported cases of an event truly had no cases or the cases that existed were not recorded. Although differences in recording probabilities may bias incidence calculations with farm-generated data, risks are usually underestimated, thus the magnitude of an observed effect is likely to be larger than estimated and any significant association is likely to be stronger in reality. Second, it is unlikely that the timing of disease is associated with the probability of recording such that estimates of time to occurrence will likely be unbiased. Finally, the diagnoses reported by farms reflect the events of concern or utility to the farm's operation and indicate either areas requiring future research, or conversely, areas needing producer education in regards to the important events to the success of the farm.
Recorded lactational incidence risks for seven of the ten most frequently reported disease syndromes in this study were consistent with previous reports; however, the recorded incidence for ketosis and mastitis were substantially lower than previously reported. The recorded incidence of uterine infection was substantially lower than two studies (Dohoo et al, 1983; Bigras-Poulin et al, 1990), substantially higher than two others (Grohn et al, 1986; Oltenacu et al, 1990), and consistent with the results of Beaudeau and colleagues (1994). Differences in rates across studies may be due to several factors: 1) each study represents a different subpopulation of animals with different underlying conditions, 2) differences exist in study design as the study by Dohoo and colleagues (1983) is a prospective study whereas the other studies (including the current study) are observational in design, and 3) differences exist in frequency calculations because of differences in case definition and population at risk. The differences in reporting across diseases reflect differences in both risk and recording probabilities. Factors that may influence reporting probabilities include: 1) the producer's perception of the importance of the disease, 2) the need for outside intervention (i.e. veterinary intervention for a displaced abomasum), and 3) the existence of standard a case definition.
Median days to first diagnosis for displaced abomasum, dystocia, ketosis, lameness, milk fever, and uterine infection were consistent with previous findings.; however, median days to first occurrence for cystic ovaries, hardware disease, and mastitis were substantially shorter than previously recorded. This may reflect regional differences in disease occurrence or perceived importance of these diseases as local education programs may emphasize one disease over another.
From the standpoint of disease modeling, the time sequence of disease occurrence is extremely important. The existence of mathematically definable relationships between diseases is paramount to attempts to simulate disease experience. With the exception of cystic ovaries, the cumulative distribution lines for the ten syndromes evaluated do not cross which suggests that a logical progression of disease occurrence may exist. Dystocia, milk fever, (and retained placenta) occur in the immediate postpartum period, while ketosis, displaced abomasum, and uterine

[4] Bestfit 1.10, Palisade Corporation, Newfield, NY 14867.

infections follow similar curves at approximately the same interval postpartum, and mastitis, pneumonia, hardware disease, and lameness tend to be recorded at a roughly constant rate throughout lactation. These apparent associations have been reported in several studies (Rowlands et al, 1986; Bigras-Poulin et al, 1990; Grohn et al, 1990; Oltenacu et al, 1990; Peeler et al, 1994) and are further supported by the finding that diseases within an apparent complex tended be fit by the same standard probability distributions.

There are several implications of this study for the development of simulation models of disease experience. First, the finding that nearly 90% of disease events recorded were one of 17 conditions substantially reduces the number of potential diseases to include in subsequent models. Second, the incidence of disease in this study was similar to previously reported rates, providing increased confidence in input parameters to use for model development. Third, the apparent existence of a logical disease progression provides a framework for developing algorithms for disease interaction. Finally, the finding that the timing of each disease could be accurately described by standard probability functions greatly simplifies the development of prediction equations for estimating timing of disease occurrence.

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