A CASE CONTROL STUDY OF ENVIRONMENTAL AND MANAGERIAL FACTORS IN THE DANISH NATIONAL MASTITIS CONTROL PROGRAM

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SUMMARY The criteria for identifying herds with high levels of mastitis in the Danish national mastitis control program were evaluated, and analyses for causal associations between mastitis and environmental and managerial factors were performed on data collected during 1983 and 1984.

INTRODUCTION The success of a mastitis control program depends among other things on the efficiency of diagnostic tests to identify affected animals and herds, the knowledge about essential causal factors, the control strategy, the quality of consultative advice and the compliance from the farmer.

Today only 2% of the 30,900 Danish dairy herds contain cows infected with Streptococcus agalactiae, corresponding to only 0.3-0.4% of the population of approximately 900,000 dairy cows (Anon 1985). However, subclinical mastitis due to other organisms is prevalent in approximately 30% of the dairy cows mainly due to infections with Staph. aureus, S. uberis and S. dysgalactiae. Estimates of the heritability of mastitis range from 0.05-0.48 in different investigations using different diagnostic criteria as summarized by Lie et al. (1980). However, most estimates refer to clinical mastitis and are less than 0.10. Jensen et al. (1985) found heritabilities ranging from 0.01-0.09 for clinical and subclinical mastitis dependent on the diagnostic criteria and on the statistical models used. The remaining part of the total variation may then be due to factors in the environment and the management and an inexplicable residual variation. Several authors, e.g. Madsen et al. (1980), Saloniemi (1980) and Bakken (1981) have demonstrated that mastitis has a multifactorial and very complex etiology. Elucidation of this complexity requires strict methodology to be used, and the design of epidemiologic studies are thus very important.

MATERIALS AND METHODS Since 1983 it has been compulsory in Denmark for all farmers delivering milk to dairies to participate in the national mastitis control program. The program is based on a surveillance system using monthly estimates of bulk tank somatic cell count (BCSS), and averages of the last six and the last three monthly values are calculated quarterly. If both averages exceed 500,000 cells/ml milk, the herd is subjected to further investigation by quarter milk sampling. The mastitis diagnosis at the quarter level is based on the CMT-reaction and microbiological findings. This is transformed to the cow level and finally to the herd level as the percentage of cows with mastitis (equal to the point prevalence rate). If the prevalence of cows with mastitis exceeds 20% the herd is visited by a technician focusing on the milking machine, the environment and the management. Intervention based on the herd investigation and the laboratory results is then recommended by the regional mastitis laboratory.

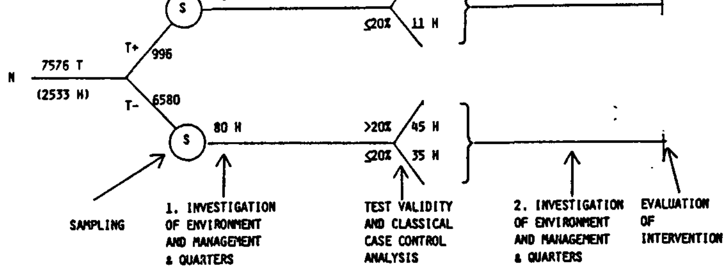

Figure 1. The investigation was designed as a modified case control study. H = herds. N = total population. S = sampling. T = BCSS-tests.

A case control design was chosen for the present study beginning in 1983, based on data from the 12 dairy districts in the region of Zealand, Lolland, Falter and Møn. Selection of herds was restricted to herd sizes greater than 15 and less than 100 cows, and among those that had not been selected in the program during the previous 12 months. Thus the cases and controls were sampled among approximately 90% of the 2533 dairy herds in the region. Whenever a case herd (i.e. a herd with both BCSS averages >500,000 cells/ml) was identified, a control herd was sampled among the non-cases within that dairy district, i.e. cases and controls were matched on time and district. For a few cases more than one control was sampled. A total of 76 cases and 80 control herds were selected during the first, second and third quarter of 1983.

Each herd was visited once in 1983 so the initial investigation was cross sectional. In addition to the routine quarter sampling and the technical evaluation of environment and management, a personal interview with the dairy man about the management was carried out by a veterinarian. Data on environment and management thus contained current and historical information.

The effect of changes in environment and management on the prevalence rate of cows with mastitis after the first investigation was evaluated from a follow up study of the same herds one year later (Fig. 1). However, 8 control herds and 7 case herds dropped out due to various reasons unlikely to distort any result from the study, i.e. 69 case and 72 control herds participated again. In the second study quarter milk samples and the environment was examined as in the first study while the interviews about management were made by telephone.

RESULTS Preliminary evaluation of the association between the average BSCC and the prevalence rate of cows with mastitis show correlation coefficients of -0.1002 and 0.1212 among case herds, and 0.3500 and 0.3572 among control herds for 3 and 6 month averages, respectively. Table 1 shows the distribution of case and control herds by mastitis prevalence rates >20% and ≤20%. The predictive value of a positive test is: Pr+ = P(>20% | >500,000 cells/ml) = 65/76 = 0.86 and the predictive value of a negative test: Pr- = P(≤20% | ≤500,000 cells/ml) = 35/80 = 0.44. Using additional information on the total number of BSCC evaluations and the number of these >500,000 cells/ml in the 2533 herds during the period of investigation (Fig. 1) it is possible to calculate the sensitivity Se = P(>500,000 | >20%) = 852/4553 = 0.19) and the specificity Sp = P(≤500,000 | ≤20%) = 2879/3023 = 0.95 of the average BSCC. Thus the sensitivity is very low and the probability of a false negative reaction is rather high (1-0.19=0.81). From Table 1 the apparent prevalence rate of herds with >20% mastitis cows is only aP = 996/7576 = 0.13 while the true prevalence rate of herds with >20% mastitis cows is tP = 4553/7576 = 0.60. Every herd, however, is evaluated 4 times a year, and therefore it is more reasonable to evaluate the test over a longer period, e.g., 12 months. The tests may be evaluated parallel according to Martin (1977), i.e. the overall result is positive if one or more of the 4 tests are positive. Thus the estimated test values are Se=0.57, Sp=0.81, Pr+=0.82, Pr-=0.56 and aP=0.42.

TEST BSCC	PERCENT COWS WITH MASTITIS WITHIN THE HERD		TOTAL
	> 20	≤ 20	
> 500,000	65 / 852	11 / 144	76 / 996
≤ 500,000	45 / 3701	35 / 2879	80 / 6580
	4553	3023	156 / 7576

Table 1. Evaluation of BSCC as a test to identify herds with point prevalence rates of cows with mastitis within the herd >20% and ≤20%. The number of study herds are in the upper left corner and the estimated number of tests below.

Causality for mastitis herd problems was evaluated using odds ratios for factors gathered in 1983. The highest odds ratios were for: recruitment policy (2.9), butter fat production (3.2), participation in milk recording societies (2.2), in service training of the farmer (2.2), use of strip cup for detection of clinical mastitis (1.8), bedding wetness (3.9), partitions between stanchions (3.3), minutes/week used to read technical literature (1.8), being active in professional associations (2.0), recording of clinical disease (1.9), and delivery of clinically changed milk (3.0). However, many factors showed tendencies that seem biological reasonable even though the odds ratios were small

Associations between changes in the mastitis prevalence rate and changes in environment and management from 1983 to 1984 were evaluated from the regression coefficient Very few variables turned out to be statistically significant: improved floor hygiene, increased vacuum reserve in the milking machine, reduced incidence of hypocalcemiae, less time for managing the cows, butter fat production, culling of the cows. However, it must be emphasized that several variables showed almost significant associations with mastitis which also seemed biological reasonable.

DISCUSSION Collection and examination of quarter milk samples are the most expensive parts in the selection procedure and therefore it is relevant to evaluate how good BSCC is to identify herds with high point prevalence rates, e.g. >20%. The results indicate that the misclassification rate is very high when only one test is carried out, corresponding to findings by Madsen et al. (1976). However, based on the parallel interpretation for a full year the test actually gives a higher percentage of correctly classified herds. The information is important for decisions about disease status in further analyses for causal associations between environment, management and mastitis at the herd level. Thus the low odds ratios found in the preliminary analyses may be due to misclassification. If not, we have to accept that each of the many causal factors can only explain a small part of the variation. Therefore it is very important to emphasize the biological tendencies (even when only slightly indicated in the data) rather than focusing strictly on the significance level.

It is well known from several other studies that there is a low correlation between BSCC and the prevalence rate of cows with mastitis. However, weighted estimates of the average BSCC may be more closely correlated with the prevalence rate. This will be elucidated in further analyses.

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