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Characteristics for mastitis incidence in dairy herds in the Czech Republic

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Abbreviation key: SCC = somatic cell count, CM = clinical mastitis

Abstract

Data on clinical mastitis (CM) incidence collected between 1996 and 2003 on five Holstein dairy farms in the Czech Republic were analyzed. The following average values were calculated for the 1st, 2nd and 3rd and subsequent lactations, respectively: 0.35, 0.45 and 0.57 for lactational incidence of CM, 0.63, 0.94 and 1.22 for the number of CM cases per cow and 0.68, 1.00 and 1.27 for the incidence rate of CM per cow-year at risk. The lactational incidence of CM and the number of CM cases per cow were calculated from data with complete lactations only, whereas the incidence rate of CM per cow-year at risk was calculated from the full data set.The analysis of CM incidence based on daily records showed the highest proportion of infected cows during the first 10 days of lactation. The incidence rate of CM per day (or per year) at risk was shown to be the best indicator for mastitis susceptibility because it accounts for the truncated character of the data and for repeated outbreaks of mastitis within a lactation.

Introduction

In the last decades of years, attention in animal breeding has been turned from production to functional traits (reproduction, longevity, health). Among the health traits, mastitis resistance is the economically most important trait in dairy cattle. Most of the recent breeding programs have tried to select for mastitis resistance using SCC as an indicator trait. The experiences from the Scandinavian countries as well as many simulation studies have shown that the direct inclusion of CM incidence in the total breeding value increases the genetic gain for mastitis resistance (Kardamideen and Pryce, 2001, Heringstad et al., 2003c-d, Odegard et al., 2003). Mastitis incidence can be expressed in different ways. Mostly, the trait is treated as all-or-non trait ignoring information from repeated occurrence of mastitis (e.g. in the Scandinavian countries). This approach can lead to an underestimation of the mastitis susceptibility. In the most recent studies, the possibility to treat mastitis incidence as longitudinal data has been taken into consideration (Schomaker et al., 2002, Heringstad et al., 2003a, Carlen et al., 2004).

The aim of this study was to establish a survey of the data for CM that exist hitherto on dairy farms in the Czech Republic and to find suitable ways to characterize mastitis resistance of cows.

Material and methods

Data description

The investigation was carried out on five Holstein dairy farms. Data from time intervals of three to seven years were available. A basic description of the collected data is given in Table 1. In all farms, strew was used for bedding and the cows were fed balanced total mixed ratio (twice a day in farms 2, 4 and 5, four times in farms 1 and 3). Farm 2 had a tied housing system, the other loose housing with (in farm 3, 4, 5) or without (farm 1) cow-run. Milking was done twice a day. All cows were dried with antibiotics in farms 2 to 5 whereas only cows treated for mastitis and high producing cows were treated in farm 1. The following information was available for each cow: starting date of CM treatment, ending date of CM treatment (end of discarding milk), number of affected quarters, the kind of applied drugs and the frequency of treatments. In farm 5, the amount of daily discarded milk was known too. Date of calving, lactation number, calving interval, culling date and test-day milk production data were also available for each cow.

Table 1. Description of the data

	Farm				
	1	2	3	4	5
Average farm size (cows)	1000	800	200	200	170
Average milk production in 1st lactation (kg)	8030	6625	6360	5903	8179
Date of starting survey	1 Jan 00	23 Dec 98	15 Feb 01	2 Feb 99	30 Jan 96
Date of ending survey	30 Jan 03	10 Feb 02	19 Nov 02	16 Jan 03	16 Jun 03
Number of full lactations in the period of survey					
1st lactation	618	430	46	128	91
2nd lactation	405	350	13	74	81
3rd and higher lactations	379	454	45	115	75
Number of full lactation periods within survey					
1st lactation	3489	2145	489	725	479
2nd lactation	2356	1723	256	424	416
3rd and higher lactations	2573	2343	548	636	476
Average length of CM case (days)[1]	5.4	5.8	8.9	7.6	7.1
SD[2] of the length of CM	1.8	2.5	3.6	4.7	6.4
Number of CM cases/ Number of infected quarters[3]					
1st lactation	369/402	862/1030	63/134	86/115	75/91
2nd lactation	534/586	727/858	63/89	70/88	119/142
3rd and higher lactations	921/1024	935/1170	142/201	141/193	191/243
Days at risk[4]					
1st lactation	383155	216246	59617	77496	49136
2nd lactation	254623	163341	47131	43832	42941
3rd and higher lactations	270584	209564	74731	66981	48673

[1]number of days when milk was discarded, [2]standard deviation, [3]in the whole period of survey, [4]corrected for the total length of diseases

Data analysis

Three data sets were created for analyzing clinical mastitis: ***Data set 1*** was formed only from records with complete lactations. For forming ***data set 2***, the lactations were divided into four periods (0 to 100 days of lactation, 101 to 200 days, 201 to 300 days or to next calving, 301 to 400 days or to next calving); records from cows not staying the whole period in the herd were not included into the calculation of mastitis incidence for this period. ***Data set 3*** was made up from daily records for CM incidence (only cows being investigated on a certain day of lactation were used for the estimation of CM incidence per day of lactation).

All analyses were done within lactations 1, 2 or higher than 2 and within each farm as well as jointly for all farms. A new case of CM for the same cow was indicated when the period between the end of the previous case and the next outbreak was at least 5 days.

The following characteristics were used for the expression of mastitis susceptibility:

Lactational incidence of CM (*LICM*):

$$LICM = \frac{\text{Number of lactations with at least one case of CM}}{\text{Total number of lactations at risk}}$$

LICM is defined for data set 1 only and is not corrected for the length of lactation.

Average number of CM cases per cow and lactation (*NLICM*):

$$NLICM = \frac{\text{Total number of cases of CM within lactations during the investigated period}}{\text{Total number of lactations at risk}}$$

where a lactation covers the whole calving interval. *NLIMC* is defined for data set 1 only.

Relative frequency of recurrence of CM (*RFCM*):

$$RFCM = \frac{\text{Number of cows treated more than ones within a lactation}}{\text{Number of cows treated at least ones within a lactation}}$$

Incidence of CM in a given period of lactation (*PICM*):

$$PIMC = \frac{\text{Number of lactation periods with at least one case of CM}}{\text{Total number of lactation periods at risk}}$$

This parameter is defined for data set 2 only.

Average number of cases of CM per cow and lactation period (*NPICM*):

$$NPIMC = \frac{\text{Total number of cases of CM within a given lactation period}}{\text{Total number of these lactation periods at risk}}$$

This parameter is defined for data set 2 only.

Incidence rate of CM per cow-year at risk (*IRCMy*):

$$IRCMy = \frac{\text{Number of cases of CM during the investigated time period}}{\text{Number of cow-days during this time period - Total number of days the cows were ill}} * 365$$

This parameter is defined for data set 3 only.

Incidence rate of quarters with CM per cow-year at risk (*IRQy*):

$$IRQy = \frac{\text{Number of quarters treated for CM during the investigated time period}}{\text{Number of cow-days during this time period - Total number of days the cows were ill}} * 365$$

This parameter is defined for data set 3 only.

Incidence rate of CM on day *i* of lactation (IRD_i):

$$IRD_i = \frac{\text{Number of affected cows at day } i \text{ of lactation}}{\text{Number of cows in the herd at day } i \text{ of lactation}}$$

This parameter is defined for data set 3 only.

Results

Table 2 summarizes the values of the above given characteristics for the occurrence of CM for the investigated farms and totally for all farms together. The values are for the first lactation. Data for the comparison of lactational incidence of CM (*LICM*) and the incidence rate of CM per cow-year at risk (*IRCMy*) between different lactations are presented in Table 3.

Table 2. Characteristics of mastitis occurrence in the 1st lactation

Variable	Farm					
	1	2	3	4	5	Total
LICM	0.24	0.61	0.48	0.25	0.33	0.35
NLICM	0.35	1.23	0.83	0.44	0.51	0.63
PICM (days)						
0-100	0.090	0.382	0.196	0.120	0.149	0.188
101-200	0.083	0.276	0.187	0.054	0.097	0.140
201-300	0.064	0.249	0.088	0.091	0.150	0.123
>300	0.081	0.146	0.149	0.039	0.064	0.080
NPICM (days)						
0-100	0.12	0.56	0.25	0.16	0.19	0.27
101-200	0.10	0.41	0.23	0.07	0.15	0.19
201-300	0.11	0.33	0.14	0.12	0.17	0.16
>300	0.07	0.19	0.17	0.05	0.10	0.10
IRCMy	0.35	1.45	0.39	0.41	0.56	0.68
IRQy	0.38	1.74	0.82	0.54	0.68	0.82
RFCM	0.30	0.54	0.45	0.48	0.30	0.44

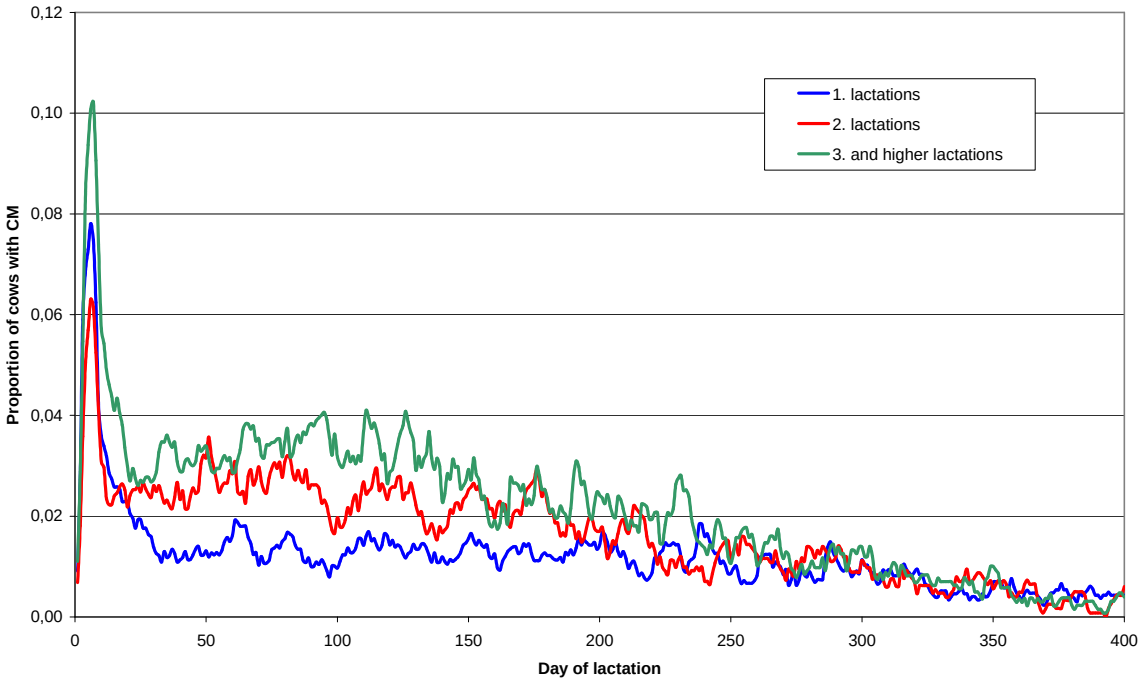
Table 3. Lactational incidence of CM (*LICM*) and incidence rate of CM per cow-year at risk (*IRCMy*) in individual lactations and farms and summarized over farms

	LICM			*IRCMy*		
Farm/Lactation	1	2	>2	1	2	>2
1	0.24	0.39	0.54	0.35	0.77	1.24
2	0.61	0.61	0.65	1.45	1.62	1.63
3	0.48	0.54	0.56	0.39	0.49	0.69
4	0.25	0.23	0.50	0.41	0.58	0.77
5	0.33	0.51	0.53	0.56	1.01	1.43
Total	0.35	0.45	0.57	0.68	1.00	1.27

LICM was on average 0.35 in the 1st lactation, but there were substantial differences between farms (from 0.24 to 0.61). The frequency of mastitis cases was the highest in the first part of lactations and increased with the parity. The recurrence of CM (*RFCM*) in the investigated sample was relatively high, 30 to 54 % of treated cows had two or more CM cases per lactation. The average number of CM cases per treated cow was 1.36 to 2.63 across parities and farms. *IRCMy* was 0.68, 1.00 and 1.27 for the 1st, 2nd and higher lactations, respectively, when summarized over farms. *IRQy* was only slightly higher because 83.4 % of the CM cases affected only one quarter; all four quarters were affected only in 1.8% of all CM cases in the total data set. *IRCMy* seems to be a similar indicator of CM susceptibility as the average number of CM cases per cow and lactation (*NLICM*). This is because the average calving interval was 411 - 417 days in lactations 1, 2 or >2, i.e. a value not very different from 365 days, the length of a year. The two quantities are the more similar the more lactations were used for the estimation of *NLICM*, but may be quite different if the number of lactations is very low, as in this case a high sampling error can occur (see the values for farm 3). Assuming an average dry period of 60 days, the average length of lactation was about 360 days. As almost all the cows were dried with antibiotics, the frequency of CM in the dry period was very low (0.5 to 1 %). This can also explain the generally lower CM incidence in the lactation period of >300 days. This period was usually shorter than the three previous periods (had a lower number of days at risk than 100).

The daily incidence rate of CM in lactations 1, 2 and > 2 (day 1 to 400) for the investigated farms is shown in Fig. 1. The highest incidence occurred during the first 10 days in milk and reached about 6 to 10 % (according to parity), then there was a sharp decline to 1 to 3 %. After the values stayed more or less stable through the next 250 days and declined again at the end of the lactation.

Fig 1: Incidence rate of CM per day of lactation



Discussion

In the literature, all of the above defined CM characteristics were used for the expression of mastitis resistance. Heringstad et al. (2003b) gave values of *LIMC* of 0.15, 0.19 and 0.24 for the 1st, 2nd and 3rd lactation, respectively, of Norwegian dairy cattle. They obtained the highest CM frequency in the period between the 1st and the 30th day of lactations 1 to 3 (0.09, 0.10 and 0.13). In the period from 31 to 120 days, *LICM* was somewhat lower (0.05, 0.09 and 0.11 for lactations 1, 2 and 3, respectively) and after 120 days (period from 121 to 300 d) in milk *LICM* rose again to values of 0.07, 0.10 and 0.11, respectively. *LICM* was about 0.04 in all lactations in the period of 30 days before calving. The periods used in Heringstad et al. (2003b) are not comparable with the lactation periods in the present study. As in our data the CM incidence before calving was very low for reasons described in Results, the days before calving were included in period four (days of lactation > 300).

Rajala and Gröhn (1998) calculated an average value of 0.17 for *LICM* in the Finish Ayshire population. Kadarmideen and Pryce (2001) estimated an average of 0.13 for *LIMC* from the analysis of 257 Holstein herds in the UK. These results showed big differences between farms, *LIMC* ranging from 0.005 to 0.57 in the individual farms. The differences between the farms in our study were not as high except of the results for farm 2 which differed from the other in the housing technology (tied system). But it must bee taken into account that the number of farms in our survey is low and the farms were not randomly chosen.

Kadarmideen and Pryce (2001) did not find any clear increasing or decreasing trend in mastitis risk with parity. On the other hand, Houben et al. (1993), who analyzed 5313 lactations of Black and White cows in the Netherlands, found a strong increase in *IRQy* from parity 1 to 3 (0.24 to 0.54). This was confirmed in our study (Table 3). De Haas et al. (2002) estimated value of 0.23 for *IRCMy* over all lactations in a data set from 274 Dutch herds. Schomaker et al. (2002) analyzed the mastitis incidence in three large German herds with a test-day model. Mastitis frequency rose till the sixth lactation day to a maximum of 0.20 (with a range from 0.076 to 0.33 between farms) and fell then to 0.02. The maximal mastitis incidence was in lactations 1 (0.23) and 4 (0.19), the lowest in lactation 2 (0.13). These values were higher than in our study, but the slope of the CM curve was similar (see Fig.1). The finding of Schomaker et al. (2002) that mastitis incidence was lowest in the 2nd lactation was confirmed as well.

The probability of recurrence of CM was rarely taken into account. Although the repeated cases of CM could be influenced by the number of treatments and by the kind of applied drugs, it can be expected that a cow with repeated occurrence of CM in the same lactation will be more susceptible to mastitis than a cow affected only ones. Therefore in our opinion, the repeated occurrence of CM should be taken into account when estimating the mastitis resistance. Esslemont and Kossaibati (1996) estimated on average 1.6 CM cases (range from 1.1 to 2.3) per treated cow from data stemming from 90 English Holstein herds which was similar to our results. The value of *LICM* varied from 0.24 in the 1st to 0.49 in the 7th lactation in these English herds.

Reviewing the literature, it can be stated that the whole lactation as well as different lactation periods were used to examine the CM susceptibility of cow groups (Lund et al. 1999, Heringstad et al. 2003a). High genetic correlations for liability to clinical mastitis were estimated between subsequent time periods (0.90 to 0.98, Heringstad et al. 2003a) as well as between lactations 1, 2 and 3 (0.65 to 1.00 for Danish breeds, Nielsen et al. 1997). Therefore, the length of the lactation period was chosen which corresponds to the common testing schemes in dairy cattle in several countries. Recently, a longitudinal model based on daily records was used for estimating the mastitis frequency (Schomaker et al., 2002). This model seems to be the most appropriate one because it handles the truncated character of the data. Each record could be used and culling of cows before the end of lactation or lactation period makes no problem anymore. In addition, the repeated mastitis cases are taken into account. A very high computing time is the disadvantage of this method.

As an alternative, the true mastitis incidence per cow and time unit (e.g. characteristics *IRCMy* or *IRQy*) seems to be good indicators for mastitis resistance. These characteristics correct CM incidence for the days at risk, that means for the length of the lactation or premature culling of each cow. It takes also into account the average number of days cows are treated for CM, because these days are not days at risk.

Conclusions

The data available recently on some farms in the Czech Republic seem to be applicable for the national recording system for mastitis resistance of dairy cows. The incidence rate of CM per cow-year at risk could be a good indicator for mastitis frequency for progeny groups of tested bulls; this indicator makes it possible to use records of all daughters independently of the length of their lactation and takes into account repeated occurrence of CM within each lactation. A more accurate analysis will be possible with a longitudinal model based on daily records. Furthermore, genetic parameters have to be estimated for the potential indicators of mastitis resistance as well as the economic value of CM. A first estimate of the economic value for CM in the Czech Republic will be presented in a companion paper (Wolfová et al., 2005).

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