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Practical use of a uterine score system for predicting effects on interval from calving to first insemination and non-return rate 56 in Danish dairy herds

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ABSTRACT

A detailed study of 398,237 lactations of Danish Holstein dairy cows was undertaken. The objective was to investigate the information gained by evaluating vaginal discharge in cows from 5 to 19 days post-partum (p.p.) using an ordinal scale from 0 to 9. The study focused on the interval from calving to first insemination (CFI) and the non-return rate 56 days after first insemination (NR56), adjusted for the confounders milk production and body condition score (BCS). For the analyses, BCS was evaluated on the same day that the uterine score was made. Milk production was defined as test-day milk yield in the first month p.p.

The study showed that the evaluation of vaginal discharge according to this score system permitted ranking of cows according to CFI and NR56, i.e. an increasing uterine score was associated with a significantly longer time from calving to first insemination and significantly reduced the probability of success of the first insemination. Reproductive success was already affected if the uterine score had reached 4 (i.e. before the discharge smelled abnormally). The negative effect on CFI and NR56 increased as the uterine score increased, which suggested that the uterine scoring system was a useful guide to dairy producers.

Introduction

Metritis is known to affect reproductive performance in dairy cows (Coleman et al., 1985; Huszenicza et al., 1999; Könyves et al., 2009). Poor reproductive performance can have significant direct and indirect costs for dairy producers, including reduced income and milk production, increased expenditures for re-breeding and a higher risk of involuntary culling (de Vries, 2006; Opsomer and de Kruif, 2009). Early indicators of reproductive performance may therefore be very useful to dairy producers. Metritis can be diagnosed earlier than 21 days post-partum (p.p.) using several indices, such as temperature (Sheldon et al., 2006), but usually relies on some evaluation of vaginal discharge. Currently, vaginal discharge early in lactation (<21 days) is not assessed using a scoring system, but the presence or absence of metritis is evaluated (Oltenacu et al., 1983; Markusfeld, 1987; Huszenicza et al., 1999; Könyves et al., 2009) and endometritis occurring after 21 days p.p., independently or as a sequel to metritis, has scoring systems available to assess vaginal discharge based on the amount, colour, smell and pus content (Williams et al., 2005; McDougall et al., 2007; Gorzecka et al., 2011).

A herd health program, based on an Israeli system (Markusfeld, 1987), was introduced into Denmark in 2006 and involves systematic weekly or bi-weekly herd visits by a veterinarian to clinically examine and record data from specific groups of cows and calves at predefined time-points. All fresh cows must be examined once during the period from 5 to 19 days after calving and scored for vaginal discharge on a scale of 0–9, based on amount, colour, smell and pus content, similar to the endometritis scoring systems (Williams et al., 2005; McDougall et al., 2007; Gorzecka et al., 2011). The scores of vaginal discharge support the decision to treat for metritis, with any score of $\geqslant 5$ (where 5 indicates vaginal discharge with an abnormal smell) generally accepted as abnormal discharge. However, the ability of early uterine discharge scores to predict later reproductive performance has never been investigated.

The objective of the current study was to investigate the information gained by evaluating vaginal discharge earlier than 19 days p.p. using an ordinal scale from 0 to 9 (‘the Danish uterine score system’). This scale was then used to determine the effects of early

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vaginal discharge on the interval from calving to first insemination (CFI) and the non-return rate 56 days after first insemination (NR56), adjusted for the confounders milk production and body condition score (BCS).

Materials and methods

Animal population and data recording

The study contained data from 398,237 lactations of 282,099 Danish Holstein cows from 1465 herds and covered the years 2006–2010. All farms included in the study performed monthly milk recordings and participated in the Danish national herd health program in which all fresh cows were examined once by a veterinarian during the period from 5 to 19 days after calving, where the cows were scored for body condition on a 5-point scale with 0.25 unit increments (Edmonson et al., 1989) and examined for vaginal discharge. The scores of vaginal discharge were made on the basis of predefined scoring schemes used in all herds (Table 1).

Data editing and statistical methods

Data from lactations greater or equal to parity 10 were excluded together with lactations where scores of vaginal discharge were made later than 19 days p.p. If more than one score of vaginal discharge was recorded in a lactation, only the first score was used. This resulted in a dataset consisting of 398,237 lactations of parity 1–9. An evaluation of BCS was performed on the same day as the uterine score was made, and this value was used in the analysis as BCS at calving. Milk production was defined as average test-day milk yield in the first month p.p. Antibiotic treatment of cows for any reason was not taken into consideration in the analyses. An antibiotic treatment might hasten the recovery from uterine infection and thereby conceal a potential negative effect on reproductive performance.

Two fertility variables were used, namely, CFI and NR56 for the first insemination. The variable NR56 was calculated as the proportion of cows not re-inseminated within 56 days after first artificial insemination (AI). A Gaussian frailty model (i.e. a Cox proportional model with random components) was used to study the CFI because this quantity may be subject to right censure (i.e. CFI is not observed but is known to be larger than a certain value). Observations with values of CFI larger than 150 were considered right censured at 150 days, since these events were rare and correspond to very atypical insemination times. The NR56 was treated as a binomially distributed response variable and modelled by a logistic model with random components representing the effects of herd by year by month. Both models are particular cases of generalized linear mixed models and were fit using the software DMU (Madsen et al., 2010).

The log-odds resulting from the logistic model were converted to probabilities using the formula: exp(log-odds)/(1 + exp[log-odds]). In the analyses regarding the effects of the different uterine scores on the fertility variables, two different models were used. Model 1 describes the effects of uterine scores, adjusting for possible effects of parity, month by year and herd (as a random component). Model 2 was similar to Model 1, but additionally included adjustment for the possible effects of BCS at calving and milk production in the first month p.p. Results were considered statistically significant if $P \leqslant 0.05$.

Table 1
Outline of the clinical findings defining the uterine score system used routinely on fresh cows 5–19 days after calving in Denmark.

Uterine score	Clinical finding
0	None or a very small amount of clear mucous secretion; no smell
1	A very small amount of bloody mucous secretion; no smell
2	Small amount of bloody mucous/grey secretion; no smell
3	Plenty amounts of bloody seromucous/grey–yellow secretion; scabs on the tail; no smell
4	Plenty amounts of grey/yellow seromucous secretion; no abnormal smell
5	Poor/plenty amounts of purulent secretion; difference in moisture and colour; smells abnormal
6	Increasing amounts of secretion; difference in texture and colour; smells abnormal
7	Increasing amounts of secretion; beginning to look red-brownish; very foul smell
8	Plenty amounts of greyish secretion; very foul smell
9	Large amounts of brown–yellow/brown secretion; typically a retained placenta; very foul smell

Results

The observed median time for examination was 9 days p.p. (mean 9.6, SE 3.7), and the initial analyses showed that mean milk production was 27.49 kg/day (SE 12.56) and mean BCS at calving was 3.28 (SE 0.41) for the cows in this study. The number of lactations to each uterine score decreased as uterine score increased, going from 132,657 (uterine score 0) to 4053 (uterine score 9) (Table 2).

Effect of uterine score on CFI

The hazard ratios of CFI for the different uterine scores are shown in Table 3 and the survival function is displayed in Fig. 1. The hazard ratios of CFI for parity, BCS and milk production are also shown in Table 3. The hazard ratios for cows with uterine scores 1–3 relative to the cows with uterine score 0 (i.e. with visually clean vaginal discharge) were 1.004, 0.999 and 0.993, respectively. However, there were no statistically significant differences in CFI for cows with uterine scores of 0–3, and the scores were combined into one reference group. When the uterine score increased above 3, the hazard ratio for first insemination decreased accordingly after adjusting for possible effects of herd, parity and month by year (Model 1). The rate at which cows with a uterine score of, for example, 6, had their first insemination was 79% of the rate for cows with uterine scores of 0–3, i.e. 21% slower for those with a score of 6. The same pattern was seen for Model 2, where we additionally adjusted for the effects of BCS at calving and milk production in the first month p.p. Here, the rate at which cows with a uterine score of (say) 6 had their first insemination was 85% of the rate for cows with uterine scores of 0–3, i.e. 15% slower for cows scoring 6.

Effect of uterine scores on NR56

From Table 4 it can be seen that when the uterine score increased above 3, the log-odds of a successful insemination decreased. There were no statistically significant differences in NR56 for cows with uterine scores of 0–3. To interpret the log-odds they were converted to predicted probabilities of a successful first insemination (Table 4). The probability of a successful insemination of a cow with uterine score 0–3 (the reference group) was set as a reference and estimated from the intercept parameter of the logistic model. The probability of a successful insemination would decrease from approximately 0.53 to 0.51 for a cow with a uterine score of 4, approximately 0.50 for a cow with a uterine score of 5, and approximately 0.49 for a cow with a uterine score of 6 or above. The log-odds of a successful insemination for parity, BCS and milk production are shown in Table 4.

Table 2
Distribution of lactations for the different uterine scores.

Uterine score	Frequency (lactations)	%	Cumulative frequency (lactations)	Cumulative %
0	132,657	33.31	132,657	33.31
1	68,670	17.24	201,327	50.55
2	66,196	16.62	267,523	67.18
3	45,440	11.41	312,963	78.59
4	27,212	6.83	340,175	85.42
5	26,937	6.76	367,112	92.18
6	12,266	3.08	379,378	95.26
7	10,022	2.52	389,400	97.78
8	4784	1.20	394,184	98.98
9	4053	1.02	398,237	100.00