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CLINICAL DISORDERS IN HOLSTEIN COWS: INCIDENCE AND ASSOCIATIONS AMONG LACTATIONAL RISK FACTORS

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Abstract

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A retrospective study of possible associations among lactational incidence risks of clinical health disorders in the current lactation in dairy cows from selected Holstein herds in Lower Saxony (Germany) was carried out on the basis of data obtained from herd health and production management programme. The associations were studied using the χ^2 test. Data on 2197 lactations of 1074 cows originated from 10 commercial herds participating for 2 to 5 years (from 1990 to 1996) in the programme. The herds had 48 dairy cows on average, milk yield of 8137 kg and mean parity of 2.9. We tested eight clinically identifiable health disorder complexes reaching the following lactational incidence risks: parturient paresis (7.0%), retained placenta (8.9%), displaced abomasum (1.1%), metritis (23.6%), clinical ketosis (1.7%), clinical mastitis (21.6%), ovarian cysts (11.7%) and claw diseases (19.5%). Dairy cows suffering from parturient paresis were at 1.4 (1.1 – 1.7) and 1.7 (1.3 – 2.2) significantly ($P \leq 0.05$) greater risk of suffering from metritis and clinical mastitis, respectively, in the current lactation. Retained placenta was significantly ($P \leq 0.05$) associated with 3.0 (2.6 – 3.5) times higher lactational incidence risk of metritis, which was a significant ($P \leq 0.05$) risk factor for ovarian cysts (odds ratio 1.4; 95% confidence interval 1.1 – 1.8). These associations provide further support to the notion that health problems in dairy cows tend to occur as a complex, especially in the postpartum period.

Dairy cattle, production diseases, occurrence, frequency, relationships

Associations among health disorders in the current lactation have been widely studied in dairy cattle either as the main objective (Curtis et al. 1983; Schukken et al. 1988; Correa et al. 1993; Massey et al. 1993; Klerx and Smolders 1997; Rohrbach et al. 1999) or more often as part of broader epidemiological studies evaluating also other potential risk factors (Dohoo and Martin 1984; Markusfeld 1987; Gröhn et al. 1989, 1990a, 1990b, 1994, 1995; Heuer et al. 1999; Loeffler et al. 1999).

Many of the disorders occurring in the early lactation increase the risk of diseases later during the current (Erb et al. 1981, 1985; Curtis et al. 1983, 1985) and following (Dohoo and Martin 1984; Calavas et al. 1996) lactation. Information regarding the relationships among diseases could be used to propose recommendations for herd health programme. Prophylactic measures to prevent the occurrence of one disorder may decrease the risk and incidence of other related disorders, either directly or indirectly (Stevenson and Call 1988).

Particular conditions of dairy cattle keeping might have specific consequences for risk of diseases (Correa et al. 1990; Klerx and Smolders 1997). Among important factors belong the breed as documented in Holstein and also other breeds (Saloniemi et al. 1986; Bendixen et al. 1987, 1988; Gröhn et al. 1989, 1990a, 1990b, 1994; Oltenacu et al. 1990; Rajala and Gröhn 1998). None of the above-mentioned studies, however, was carried out in Germany.

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The aim of this study was on the basis of data obtained within herd health and production management programme to verify in a retrospective way whether and to what extent there were any associations among lactational incidence risks of health disorders including parturient paresis, retained placenta, displaced abomasum, metritis, ketosis, mastitis, ovarian cysts and claw diseases in the current lactation in dairy cows from selected Holstein herds in Lower Saxony.

Materials and Methods

Data on 2197 lactations of 1074 dairy cows were gathered from 10 herds in Lower Saxony, Germany. The herds were kept on private family farms with milk production as their main aim. Regarding animals, milk yield and management, these dairies were typical of Lower Saxony and had traditionally high standards of nutrition, technique and hygiene of milking, housing and care. Table 1 presents mean values of numbers of cows, milk yield, milk fat and protein content, and parity in the individual herds and the whole. The proportion of the first, second, third, fourth, fifth and higher lactations in the whole data sample was 33%, 22%, 15%, 11%, 7% and 12%, respectively.

Table 1
Mean values of numbers of cows, milk yield, milk fat and protein content, and parity in studied Holstein herds in Lower Saxony

Herd	Number of cows	Milk yield (kg)	Milk fat (%)	Milk protein (%)	Parity
1	53	8656	4.37	3.51	2.6
2	48	6649	4.57	3.51	2.6
3	55	9017	4.11	3.46	3.2
4	46	7599	4.40	3.32	2.2
5	63	8413	4.38	3.38	3.2
6	65	8476	4.37	3.37	3.0
7	44	8124	4.29	3.39	2.6
8	17	7882	4.37	3.21	3.2
9	46	7984	4.07	3.43	3.1
10	43	8572	4.52	3.40	3.7
All	48	8137	4.35	3.40	2.9

Feeding rations for all herds were set up by independent nutrition advisers on the basis of feed analyses. Their effect was evaluated, besides other, using monthly measured individual milk yield and milk content (fat, protein, urea, somatic cell count) and the body condition scoring (BCS). Maize silage and grass haylage were the basic preserved voluminous feeds used in all herds. Roughage feeds were mixed for herds No. 2,3,4,5 and 7. Except for herd No. 4, dairy cows were grazed during the day from sprig to autumn. Free stall housing was used in 9 herds (8 of which were kept on slatted concrete floor, herd No. 6 was kept on concrete floor) with litter bed boxes and concentrate feed was allocated to feeding boxes depending on the individual milk yield. Only herd No. 8 was kept in tie housing. Except this herd, all the other were milked in herringbone milking parlours. When drying-off a cow, intramammary administered antibiotics were used as a rule in all herds. Further characteristics of these herds were published by Kehler (1993), Drumm (1997) and Wilhelm (1997) in detail.

These herds participated for 2 to 5 years in herd health and production management programme organised by two clinics of the College of Veterinary Medicine in Hanover. Kehler (1993), Metzner et al. (1993) and Wilhelm (1997) described the form and extent of this veterinary care. Systematic reproduction control was the basic part of the programme in all herds. Depending on specific needs of individual herds, other parts of the programme were aimed at health promotion and production increase, together with the herd economy improvement and professional contentment of the staff. The herds were visited at 2-to-4 week intervals. Topical data concerning the situation in the herd were sent to the clinic one-to-two days before the veterinarian-in-charge visit and saved using the special herd management computer program BOVI-CONCEPT (version 5.5; Z. Metzner Software,

Hanover, Germany) (Metzner and Merck 1991). Results of milk yield check were also saved in the data-file. Using this computer program proposals of individual animals to be examined by the care-taking veterinarian, goals and plans for the animal breeders for weeks following the visit were outlined. The visit consisted of gynaecological examinations (Metzner et al. 1993; Wilhelm 1997), mammary gland health status checks (prior to drying-off in all cows, during lactation in problem animals), biological material sampling, other clinical examination of animals, their treatment and proposals of further remedial measures. On some occasions BCS, checks of calf and heifer rearing, climate in the stable, milking equipment including hygiene of milking were performed. The second part of the visit was devoted to the evaluation of effects of the feeding ration and consulting the above-mentioned problems using computer outlines, evaluations and graphical presentations.

Selected clinically diagnosed health disorders noticed by the breeder, production medicine or local veterinarian were recorded using the Bovi-Concept program and categorised as following health disorder complexes: 1. parturient paresis - up to the 10th day post partum, 2. retained placenta - 24 h post partum at minimum, 3. displaced abomasum (diagnosed by the veterinarian) - most cases confirmed by surgery, 4. metritis - an abnormal vaginal discharge, cervical discharge or both or uterine content (farmers did not examine the animal rectally), 5. clinical ketosis - decreased appetite and elevated urine ketones in the absence of concurrent diseases within 5 d before and after detection of ketosis, 6. clinical mastitis – visually abnormal milk secretion (e.g., clots, flakes, or watery), 7. ovarian cysts (diagnosed by the veterinarian) - estrus cycle disturbances without palpable corpus luteum accompanied by findings of follicular structures of over 2.5 cm diameter on the ovarium (in cases in which it was not possible to come to unambiguous findings using palpation, ultrasonographic examination was performed or progesterone level in milk was determined). The definition of the above seven disorder complexes was nearly the same as recommendations by Kelton et al. (1998). 8. claw diseases - including diseases of skin in this area; as defined by Espinasse et al. (1984).

It was only the first case of health disorders belonging to the evaluated complex occurring up to the 305th day of lactation that was included into the evaluation of health disorder complexes in each lactation (it is, thus, the lactation incidence risk that was investigated). For the purpose of evaluating individual health disorder complexes and their associations we used data from those herds in which health disorders belonging to health disorder complexes were routinely recorded. Parturient paresis and displaced abomasum were not a part of the health program in the herd No. 7. Ketosis was not included in the health programme in herds No. 5 and 7. Mastitis control was not included in the health programme in herds No. 7, 9 and 10. Claw diseases were part of the health programme only in herds No. 1, 2, 3, 4 and 6.

Data were statistically evaluated using the computer program "Statistical Analysing System" (SAS) (SAS User's Guide, 1990). Basic epidemiological characteristics of individual health disorder complexes included such values as lactational incidence risk (LIR) and median postpartum days at diagnosis. Associations between LIR of one health disorder complex and LIR of other complexes with higher medians of the number of days post partum at the first occurrence were evaluated using the χ^2 test in the SAS procedure PROC FREQ.

Table 2
Lactational incidence risks (LIR)[1] and median postpartum days at diagnosis of clinical health disorders in Lower Saxony Holstein cows

Disorder complex	LIR (%)	Median postpartum day at diagnosis	Number of herds included	Lactations
Parturient paresis	7.0	1	9	2026
Retained placenta	8.9	1	10	2197
Displaced abomasum	1.1	18	9	2026
Metritis	23.6	24	10	2197
Clinical ketosis	1.7	27	8	1734
Clinical mastitis	21.6	54	7	1598
Ovarian cysts	11.7	61	10	2197
Claw diseases	19.5	76	5	1267

[1]LIR = affected lactations per 100 lactations at risk

Results and Discussion

Table 2 gives LIR and median time in days from calving to the first diagnosis computed on the basis of health records concerning individual health disorder complexes in the computer program Bovi-Concept. The table also provides numbers of herds and lactations which were evaluated in individual health disorder complexes.

Compared to the survey by Kelton et al. (1998) we found lower LIR values of displaced abomasum and clinical ketosis. This could probably be due to good production management (e.g. energy-rich ration, continuous augmentation of concentrates during dry off time) and herd health service (e.g. monitoring of BCS and milk components). Concerning ketosis, the difference could partly be due to the restrictive inclusion criteria used in this study (clinical ketosis in the absence of concurrent diseases within 5 days before and after detection of ketosis). In other health disorder complexes our values were higher than the median LIR or median incidence rate of comparable diseases. The complex of claw diseases in our study included most often following diagnoses: pododermatitis circumscripta (44%), dermatitis digitalis bovis (26%), interdigital hyperplasia (18%) and laminitis (9%); and in the current lactation there could have been two and more problems in one dairy cow.

While some of the above-mentioned studies were based on records of therapy performed by a veterinarian (Saloniemi et al. 1986; Gröhn et al. 1989, 1990a, 1990b, 1994; Rajala and Gröhn 1998) or veterinary diagnoses (Gröhn et al. 1995), our study includes also those cases of disease which were not evaluated by a veterinarian but were diagnosed and sometimes even treated only by the breeder (e.g., clinical mastitis, claw diseases, parturient paresis, retained placenta). We can say that more detailed and complex health data and reduction of a number of possible bias caused by breeders, for example, because of their different ability to treat some diseases without veterinary help and advice or their selective willingness to call veterinarians to individual animals with regard to their milk yield and breeding value, were preferred over the precision of diagnosis. The degree of these influences can be partly evaluated from the fact that, as opposed to our results, Gröhn et al. (1989, 1990a), even when having a much broader spectrum of diseases studied, had records on health problems in about half of lactations (33.3%). There were, however, noticed health disorders of at least one kind in 63.9% (53.6 to 76.4%) of lactations in our subset of five herds, in which records of all the evaluated health disorders were kept.

Testing 27 possible associations we evaluated, four statistically significant associations were found among health disorder complexes and another one being rather a trend. The significance level was fixed at $\alpha = 0.05$. This result is comparable to the detailed study by Dohoo and Martin (1984) who found in a similarly numerous data base after the first step with partial consideration of the chronology 32 out of 136 possible relationships ($P \leq 0.1$). More than one half of them, however, was not verified using detailed analyses.

As it is seen from Table 3 no of the health disorder complexes was protective; this fact being in accordance with most studies analysing associations among diseases (Curtis et al. 1983, 1985; Erb et al. 1985; Bendixen et al. 1988; Gröhn et al. 1989, 1990a, 1990b, 1994, 1995; Oltenacu et al. 1990; Correa et al. 1990, 1993; Klerx and Smolders 1997; Heuer et al. 1999). Some papers occasionally mention lower incidence of a health disorder in individuals that suffered from and were treated because of a certain previous disease (Dohoo and Martin 1984; Bendixen et al. 1987; Calavas et al. 1996; Rajala and Gröhn 1998; Loeffler et al. 1999).

A health disorder complex as a significant risk factor for another health disorder complex in our data was found in the following cases: In dairy cows suffering from parturient paresis we found 1.4 times higher LIR of metritis than in those ones in which there was no parturient paresis recognised in the current lactation. Dairy cows suffering from retained placenta had 3.0 times higher LIR of metritis as well. Parturient paresis was also associated with 1.7 times higher LIR of mastitis. In lactations in which there was metritis we found 1.4 times higher LIR of ovarian cysts. Apart from the mentioned odds ratios this table also presents their 95% confidence intervals and numbers of cases on the basis of which the associations were found.

Table 3
Odds ratios (OR) and 95% confidence intervals (CI) for significant ($P \leq 0.05$) associations among lactational incidence risks of clinical health disorders in Holstein cows

Disorder complex (cases)			Odds ratio	
Dependent	Independent	Both	OR	CI
Displaced abomasum	Parturient paresis			
23	142	4	2.8	1.0 – 8.1
Metritis	Parturient paresis			
487	142	45	1.4	1.1 – 1.7
Metritis	Retained placenta			
518	195	117	3.0	2.6 – 3.5
Clinical mastitis	Parturient paresis			
345	117	41	1.7	1.3 – 2.2
Ovarian cysts	Metritis			
256	518	78	1.4	1.1 – 1.8

Significance of the above-mentioned associations is clear from the fact that the 1.0 value lies outside the 95% confidence interval. The real value lies with 95% probability within this interval. It is, however, necessary to realise that the fact of finding associations among diseases in observational field studies using data from commercial herds does not necessarily mean that they really exist. They may be created only by the organisation of health care or statistical data processing. It is, for example, possible that once a disorder was diagnosed, the farmer or the veterinarian would observe the cow more closely for other diseases (Gröhn et al. 1989). This is, nevertheless, the policy recommended by Curtis et al. (1985) for the purpose of recognising all health disorders. There may be noticed a seemingly protective influence of one health disorder on the other. For example, less frequent anestrus treatment after teat injury and after the frequently following mastitis (Rajala and Gröhn 1998) is probably caused by the dairy cow exclusion from reproduction.

Analysing our data we found a trend of associations between parturient paresis and displaced abomasum. Displaced abomasum was 2.8 times more frequent in dairy cows suffering from parturient paresis. This result at the limit of statistical significance ($P = 0.05$) is to be evaluated with caution because it is based on only 4 cases of these two diseases affecting the same animal. In order to prove this association we would need more numerous data sets. The importance of the size of data set is treated by Gröhn et al. (1989). Though in their sample the LIR value of abomasal disorder amounted only to 0.5%, probably due to n > 40,000, the relationship between parturient paresis and abomasal diseases was statistically significant and of similar value as in our study, i.e., 2.5 (1.8 to 3.7). The size of their data set provided great statistical power and enabled examining rarer disorders. They, thus, were able to find relationships not described up to the time. They, however, warn that especially these cases may be loaded by the type I - error (alfa).

Though multivariate analysis in some studies (Dohoo and Martin 1984; Curtis et al. 1985; Markusfeld 1987; Gröhn et al. 1995; Loeffler et al. 1999; Heuer et al. 1999) has not found the association between parturient paresis and displaced abomasum, this association was proved using multivariate analysis, apart from the above mentioned paper by Gröhn et al. (1989), also by Correa et al. (1993) and Rohrbach et al. (1999). It was also noticed earlier in more simple studies (Robertson 1966; Hull and Wass 1973; Hesselhot and Grymer 1978; Curtis et al. 1983). Differences in the evaluation of the

association discussed by Curtis et al. (1983, 1985) and Correa et al. (1993) may be explained by a combination of influences of data set size and the statistical method used. These three studies evaluated to a greater extent the same data, originated in the same source, and the data collection started at the same time. The association found using a simple bivariate analysis of these data (Curtis et al. 1983) disappeared in multivariate analysis (Curtis et al. 1985). In a later study (Correa et al. 1993) evaluating many more data from a longer period the association between parturient paresis and left-side displaced abomasum was found again using multivariate analysis. Another possible reason why no association was found between parturient paresis and displaced abomasum in the above-mentioned multivariate analysis was the mediation by other disorders (Curtis et al. 1985), especially by retained placenta (Erb and Gröhn 1988). Even the hypocalcemia lowering the abomasal motility (Huber et al. 1981; Daniel 1983) was found to be a risk factor for displaced abomasum (Massey et al. 1993; Geishauser et al. 1998). In accordance with Erb and Gröhn (1988) we arrived at the conclusion that the parturient paresis is most probably a risk factor for the displaced abomasum.

Higher occurrence of mastitis following parturient paresis, which is in accordance with our finding, was also proved by Curtis et al. (1983, 1985), Bendixen et al. (1988), Schukken et al. (1988), Correa et al. (1990) and Gröhn et al. (1990b). Parturient paresis may be such a stress that it increases the susceptibility to other clinical syndromes or an affected cow is recumbent and probably misses at least one milking. This increases exposure of the udder to pathogens (Curtis et al. 1983). Considering only mastitis cases occurring up to the 30th day post partum (Curtis et al. 1983, 1985; Schukken et al. 1988), the association of parturient paresis and mastitis was obviously greater. The association with later-occurring mastitis cases may be indirect or not (Bendixen et al. 1988).

Both the association of parturient paresis and metritis that was found within the framework of our study and also by other authors (Dohoo and Martin 1984; Saloniemi et al. 1986; Markusfeld 1987; Gröhn et al. 1990a, 1994) proved the relationship of milk fever and metritis. This supports the idea that milk fever is a risk factor for several reproductive disorders (Gröhn et al. 1990a) or more generally said that milk fever plays a central role linking to all of the other disorders (Erb and Gröhn 1988).

Retained placenta influenced the LIR of metritis complex to a greater extent than parturient paresis. It was the closest association we found. Close relationship of retained placenta and metritis was observed very often (Dohoo and Martin 1984; Erb et al. 1985; Gröhn et al. 1990a, 1994, 1995; Calavas et al. 1996; Klerx and Smolders 1997; Heuer et al. 1999; Loeffler et al. 1999).

The complex of metritis was a risk factor for the ovarian cysts. This finding is in accordance with studies that mention more frequent occurrence of the ovarian cysts following metritis (Erb et al. 1981, 1985; Dohoo and Martin 1984; Gröhn et al. 1990a, 1994; Oltenacu et al. 1990; Rajala and Gröhn 1998). As an explanation, Bosu and Peter (1987) suggested that uterine infection might lead to increased secretion of cortisol and $PGF_{2\alpha}$, which would increase the incidence of cysts. Peter et al. (1989) showed that intrauterine infusion of endotoxin could increase the incidence of cysts. Contrary to this, Loeffler et al. (1999) found statistically significant protective influence of metritis on the occurrence of cystic ovarian disease.

All the above-mentioned comparisons seem to confirm that, even if we used only bivariate analysis for our study, the associations found do not belong to the category of spurious associations as it is discussed, e.g., by Dohoo and Martin (1984) admitting that since a large number of possible associations were investigated in their study, it is possible that some associations were found to be statistically significant due to chance alone. Associations, nevertheless, do not necessarily mean cause-and-effect; associations could be

causal in nature but also could reflect underlying aetiologies held in common by both disorders. In the latter instance, the disorder that is a risk factor for another disease is an indicator variable for the underlying common cause (Erb and Gröhn 1988). Both mechanisms may, however, take part in the process (Erb et al. 1981). Hypocalcemia, for example, may be a common predisposing factor for several periparturient disorders. Considering parturient paresis there are, however, obvious interrelationships among dystocia, retained placenta, metritis and cystic ovary (Gröhn et al. 1990a).

Evaluated as a complex, analyses of associations, including the one we performed, reveal extensive interrelationships of various health problems and the authors (e.g., Ekesbo 1966; Stevenson and Call 1988; Gröhn et al. 1990a; Correa et al. 1993) come to the conviction that a lot of the most important periparturient health complications occur as a part of a complex, rather than appearing as a single abnormality and are affected by various management factors (Correa et al. 1990). Results of the study by Lyons et al. (1991) even suggest that dairy cows susceptible to any type of health problems are probably more prone to suffer from other health problems.

Diseases in dairy cattle are thus to be considered as a complex system and it is not possible to study any of them independently of other health problems (Calavas et al. 1996). The obtained results testify for the associations among health disorders studied under conditions of countries with good breeding policies (Fleischer 1998). The above-mentioned knowledge may be used for the purpose of proposing herd health and production management programme.

Souvislosti mezi incidencemi klinických zdravotních poruch holštýnských dojnic

Na základě údajů získaných v rámci programů pravidelné produkčně preventivní veterinární péče bylo retrospektivně ověřováno, zda a do jaké míry se u dojnic ve vybraných chovech Dolního Saska (Německo) uplatňují v dané laktaci souvislosti mezi incidencemi (ve formě lactational incidence risk) klinicky diagnostikovatelných zdravotních poruch. Souvislosti byly zkoumány pomocí χ^2 testu. Použita byla data z 2197 laktací od 1074 dojnic z 10 produkčních chovů, které byly v letech 1990 až 1996 do programů zapojeny po dobu dvou až pěti let. Tato stáda měla v průměru 48 (17 – 65) dojnic, mléčnou užitkovost 8137 kg (6649 – 9017 kg) a průměrné pořadí laktace bylo 2,9 (2,2 – 3,7). Bylo testováno osm komplexů zdravotních poruch s těmito incidencemi: porodní paréza (7,0 %), zadržení lůžka (8,9 %), přesunutí slezu (1,1 %), metritis (23,6 %), klinická ketóza (1,7 %), klinické mastitidy (21,6 %), syndrom ovariálních cyst (11,7 %) a onemocnění paznehtů (19,5 %). Dojnice, u kterých se vyskytla porodní paréza, měly v této laktaci statisticky průkazně ($P \leq 0,05$) 1,4 (1,1 – 1,7) krát vyšší riziko postižení metritidou a 1,7 (1,3 – 2,2) krát vyšší riziko vzniku mastitid. Zadržení lůžka bylo průkazně ($P \leq 0,05$) spojeno s 3,0 (2,6 – 3,5) krát vyšší incidencí metritid. Ta byla signifikantním ($P \leq 0,05$) rizikovým faktorem pro syndrom ovariálních cyst (odds ratio 1,4; 95% interval spolehlivosti 1,1 – 1,8). Nalezené souvislosti podporují poznatek, že zdravotní poruchy u dojnic mají tendenci se vyskytovat v návaznosti na sobě jako komplex a to především v poporodním období.

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