Acta vet. scand. 1994, *35*, 337-347.

Skin Injuries on the Body and Thigh of Dairy Cows: Associations with Season, Claw Health, Disease Treatment, and other Cow Characteristics

By *C. Enevoldsen*[1], *Y. T. Gröhn*[2], and *I. Thysen*[3]

[1]National Institute of Animal Science (NIAS), Tjele, Denmark, [2]Section of Epidemiology, Department of Clinical Sciences, New York State College of Veterinary Medicine, Cornell University, Ithaca, New York USA, and [3]Danish Informatics Networks in the Argicultural Sciences (DINA), Tjele, Denmark.

Enevoldsen C, Y.T. Gröhn, and I. Thysen: Skin injuries on the body and thigh of dairy cows: Associations with season, claw health, disease treatment, and other cow characteristics. Acta vet. scand. 1994, 35, 337-347. – An epidemiological study was conducted in 18 dairy herds with the objective to characterize those groups of cows where skin injuries to the body and thighs occurred most frequently. Data were analyzed with multivariable logistic regression. The epidemiologic patterns were different in first and later lactations. In first lactation some degree of injury occurred among 7.7% of 1793 cows. For most cows occurrence of sole ulcer was positively associated with injury while occurrence of heel horn erosion was negatively associated with injury. The association between injury and body weight differed depending on month of calving (significant interaction). Injuries occurred most frequently among high yielding cows. Severe reproductive, metabolic, and/or infectious diseases were associated with injuries. In later lactations some degree of injury occurred among 13.4% of 832 cows in lactations 2 to 9 where severity of injury increased with lactation number. Injuries occurred least frequently at examinations made in the January to March. They occurred most frequently among cows with sole ulcers. Calving in March through October was associated with injuries especially if the cows were treated for limb disorders. Most cases of injuries occurred early or late in lactation or among high or very low yielding cows in lactations 2 to 9.

Contusions; animal welfare; dairy cattle; herd health.

Introduction

Physical injuries to the body and thighs in dairy cows vary from hardly visible hair loss and thickening of the skin covering single protruding points to extensive necrosis and inflammation of several muscle groups or even bones. Such conditions are well known sequels to accidents and paralysis. It is also evident that a wide range of constructional features of dairy cow housing systems may cause injuries. Physical injuries are, however, rare as primary reasons for veterinary treatments. Consequently, the occurrence of any physical injury observed by a veterinary practitioner during herd visits is an important indicator of the herd health status and a negative effect of the production environment. The occurrence of injuries observed by the meat inspectors at the slaughter house could, similarly, be important indicators of poor production conditions. Systematic measurement of such injuries and equivalent signs of "ill health" have been suggested as potentially the most objective measures of animal welfare (*Ewbank* 1986). Ex-

periments with and testing of dairy cow housing types, design, flooring, and equipment often use the prevalence of physical injury to the animals as a main dependent variable although insufficient standardization of injury recording is claimed to be a major deficiency of many such studies (*Webb & Nilsson* 1983). Skin damage as a result of production conditions has also been identified as a cause of considerable direct economic losses due to decreased leather quality (*Hagenlocher & Schroer* 1990).

Regular monitoring of the occurrence of injuries in herds or other populations of animals exposed to some common predisposing factor(s) can, however, be severely biased if some important animal characteristics also predispose to injury. If, e.g., injuries are related to parity and parity distribution changes over time in a population then the effect of parity must be accounted for before inferences about changes in the prevalence of injury in the population can be made. Consequently, it is necessary to study whether the occurrence of injuries is systematically related to important cow characteristics before valid and precise monitoring schemes for populations can be set up. In addition, knowledge about associations among cow characteristics and health disorders can provide a foundation for inferences about causal relations. Principles and methods for monitoring and causal inference from observational health data in dairy herd health management are described in detail by *Enevoldsen* (1993).

The purpose of this study was to describe the occurrence of physical injuries on the body and thighs of dairy cows in relation to potentially important cow characteristics. Based on these associations possible causal relations and the implications of the findings for monitoring health of cow populations are discussed.

Materials and methods

Data

A subset of data from Danish loose housed dairy herds collected from 1978 until early 1982 to estimate the effect of dairy cow housing systems on health, reproduction, production, and economy (*Østergaard* 1985) was used for this study. The data included 15 herds with Danish Black and White cows which can be compared with Holstein Friesians, and 3 herds with cows of the Red Danish Milking Breed which are dual purpose cows with approximately the same size and milk yield as the Danish Black and White breed (average herd size ± sd = 85 ± 21). The loose housing systems were equipped with either solid floor and scraper or slatted floor. Four of the 18 herds grazed during 1 or more summer seasons or had access to an exercise pen in the study period. All of the herds were visited weekly by technicians employed by the National Institute of Animal Science. The technicians were responsible for recording milk yield, body weight at calving (actual weight at first calving and hearth girth measurement at the subsequent calvings), body weight in the spring and fall and at culling, and dates of calvings and cullings. The flat rate feeding principle was applied in all herds. All treatments requiring injections and/or use of antibiotics were performed by the local practicing veterinarians who recorded cow identification number, date of treatment, and diagnosis. Recordings were verified by the technicians. Claws were trimmed during the first 3-4 months of lactation and again 6 months later. The claw health of each cow was recorded at these times; thus, a record was made at least twice in each lactation. At each trimming, a detailed evaluation of the digits was performed as described by *Enevoldsen et al.* (1991a & b).

All cows were examined by 1 of 3 members of

the scientific staff from the Department of Internal Medicine at The Royal Veterinary and Agricultural University in Copenhagen 3 times per year. Prior to each visit the 3 observers examined a number of cows together to minimize observer differences. Degrees of contusions and/or wounds with or without exudation on the costal arch, thigh, hip, and ischial areas on the cows were considered for the analysis (will be further described below).

Statistical analysis

The data were analyzed with a multivariable logistic regression technique as described in detail elsewhere (*Enevoldsen et al.*, 1990). The statistical analysis was performed in 4 stages: 1) data editing, 2) data reduction, 3) model selection, and 4) estimation of associations.

Data editing

The dependent variable was created from the observations of the clinical condition (contusion and/or wound) of the costal arch, thigh, hip, and ischial areas. The variable could have 4 values as estimates of the worst clinical condition recorded anywhere at these locations. These 4 values corresponded to the following symptoms: 1) Degree 0: No clinical symptoms of injury. 2) Degree 1: Alopecia. Minor hyperkeratosis. 3) Degree 2: Major hyperkeratosis. Edema. Bursa formation. 4) Degree 3: Wound(s) and/or inflammation with exudation (i.e., all degrees of wounds were included in degree 3). For the analysis the last observation made no later than 300 days after calving was selected.

The independent variables were analyzed as categorical variables. Values of the continuous variables (stage of lactation, milk production, and body weight at calving) were initially ranked from lowest to highest and then grouped into 7 categories of approximately equal size (i.e., 13-16% of observations in each group).

The variable disease included veterinary treatments only. The following groups were created initially: 1) periarthritis of the tarsal joint; 2) disorders of the digits, e.g., interdigital phlegmon and sole ulcer; 3) disorders of the carpal joint; 4) limb disorders other than groups 1 to 3; 5) those reproductive disorders expected to be severe enough to impair foot and leg health, e.g., severe metritis and pyometra; 6) metabolic/digestive disorders expected to be severe enough to impair foot and leg health, e.g., left displaced abomasum and rumen acidosis; 7) those infectious disorders expected to be severe enough to impair foot and leg health, e.g., summer mastitis and peritonitis; 8) all other disorders, e.g., other mastitis, retained placenta, and non-severe metritis. A cow was categorized as having experienced one of these »diseases« if at least 1 treatment was performed between 21 days before calving and the day of examination for physical injury.

Heel erosion (erosio ungulae) was recorded in 5 degrees from 0 representing no erosion to 4 representing exposure of the pododerm. Sole ulcers were recorded in 6 degrees from 0 representing no sign of sole ulcer to 5 representing an exposed pododerm (*Smedegaard* 1964a & b). The cows were categorized according to the degree of heel erosion in front and hind digits. Recordings from claw trimmings performed between calving and 60 days after the day on which the cows were examined for injuries were included in the data set. When several observations of claw health were available for a cow in one lactation the most severe degree was used for the analysis.

Season of year (when the clinical examination was performed) was defined as January to March, April to June, and October to December. The variables herd and year of calving were combined into one variable (herd-year of calving), which indicated the calving year

Table 1. Variables associated with skin injuries on body and thigh of 1793 cows (=N) in first lactation.

Description of variables[1]	% of N	Odds Ratio[2]	95 % C.I.[3]
Month of Calving & Body Weight at Calving (BW, kg)			
March-June & (BW<455 or BW>489)	13.6	2.2	1.0-5.1
March-June & BW 455-489	5.8	3.3	1.3-8.3
July-February & (BW<455 or BW>489)	58.2	2.2	1.2-4.1
July-February & BW 455-489	22.4	1.0	...
Milk Yield (4% FCM, kg), mean per day during days 0 to 100 in lactation			
FCM>19.1 kg (mean+sd=21.4+2.0)	42.8	1.8	1.2-2.7
FCM<19.1 kg (mean+sd=16.1+2.2)	57.2	1.0	...
Veterinary Treatment			
Severe reproduction, metabolic/digestive, and/or infectious disorders	8.9	1.9	1.1-3.3
Other disorders or no treatment	91.1	1.0	...

1 In addition, herd-year of calving and the variables described in Fig. 1 are included in the final logistic regression model.

2 Odds ratio is a relative measure of association. E.g., an odds ratio value of 2.0 for a row indicates a 2.0 times higher frequency of injury compared to the row with odds ratios 1.0, i.e., a positive association among injury and the risk factor under study. See text and basic epidemiologic textbooks for details.

3 95 % C.I. is the 95 % confidence interval of the odds ratio. If 1.0 is not included in the interval, then the actual odds ratio is said to be statistically significantly different from 1.0 at the 5% level.

and the herd identity. Calving year was from November 1 to October 31. The data set contained only 215 observations from lactations 4-9. Consequently, these data were combined leaving the variable parity with 4 classes.

Data reduction, model selection, and estimation of association

Except for the herd-year of calving variable all two-factor interaction (product) terms were examined in the analysis. Through an analysis of deviance, product and lower order terms were removed from the model until the difference in values of -2 log (likelihood) of the models at the corresponding degrees of freedom was statistically significant at the 5-10 percent alpha-level (the likelihood ratio test). Model fit was similarly assessed by means of the likelihood ratio test. The associations between the dependent and the independent variables were estimated as odds ratios (OR). The odds of an event, say injury, is defined as the probability of injury occurring (p) divided by (1-p). The OR is defined as the odds of injury occurring in one group of individuals, e.g., cows with a history of dystocia, divided by the odds of injury in a relevant »control group« of cows, in this example cows without dystocia. If an odds ratio has the value one, there is no statistical evidence of an association. Values above or below one (1) provide evidence of positive or negative associations, respectively. An OR value of injury = 2.0 for dystocia compared with no dystocia can be interpreted as injury being 2.0 times more likely to occur among cows with a history of dystocia compared to cows without dystocia. For each odds ratio a 95% confi-

Table 2. Variables associated with skin injuries on body and thigh of 832 cows (=N) in lactations 2 to 9.

Description of variables[1]	% of N	Odds Ratio[2]	95 %C.I.[3]
Parity			
Lactations 4-9	25.8	2.9	1.6- 5.1
Lactation 3	28.0	1.8	1.0- 3.2
Lactation 2	53.8	1.0	...
Month of Calving & Disease (limb disorders)			
March-October & Disease	7.5	6.8	2.9-16.0
March-October & no Disease	51.7	2.1	1.1- 3.8
November-February & Disease	5.1	0.6	0.2- 2.3
November-February & no Disease	35.7	1.0	...
Stage of Lactation at Observation (Days In Milk, DIM)			
DIM<159 or DIM>240	57.2	2.4	1.4- 4.1
DIM 159-240	42.8	1.0	...
Milk Yield (4% FCM, kg) mean per day during days 0 to 100 in lactation			
FCM<20.6 or FCM>24.4	71.4	3.2	1.7- 5.9
FCM 20.6-24.4	38.6	1.0	...

1 In addition, herd-year of calving and the variables described in Fig. 1 are included in the final logistic regression model.
2 & 3 See text to Table 1.

dence interval was calculated. If the interval does not include one (1) the association is regarded as statistically significant at the 5 percent level. For details on calculation and interpretation of odds ratios, see basic epidemiologic textbooks. The currently applied analytical strategy is described and discussed in detail by *Enevoldsen et al.* (1990).

Results

Parity is regarded as an important risk factor for most diseases in dairy cows. Because of the markedly different body weight, production level, disease patterns, and management conditions prior to and around calving, first parity cows were analyzed separately from later parities. In each parity group only 1 observation per cow was included. This division of the data resulted in 2 different statistical analyses. Main results of these analyses are presented in Tables 1 and 2 and in Fig. 1 and 2.

Injuries in first lactation

Injuries of the degrees 1, 2, and 3 occurred among 4.5, 1.1 and 2.1 percent of the 1793 cows in the first lactation, respectively. The final model included 3 two-factor interaction terms between body weight (BW) and month of calving, season of year and sole ulcer, and heel erosion in the fore feet and sole ulcer. If an interaction term between BW and month of calving (a two-factor interaction term) is significant and, consequently, included in the statistical model, it means that the relation between injury and BW is different in different calving months. Numerous such interactions were revealed in this study.

The estimates of association between injury

and the 12 possible combinations of the 3 variables season of year, sole ulcer, and heel erosion are presented in Fig. 1. It is evident that examinations in January to March and October to December compared with April to June were associated with a higher risk of injury for all possible combinations of sole ulcer and heel erosion. For cows with sole ulcer, injuries occurred most frequently in fall. For cows without sole ulcer, injuries occurred most frequently in April to June. Irrespective of sole ulcer and season of year, heel erosion appeared to be associated with a decrease in injury occurrence; perhaps most markedly among cows without sole ulcer.

For cows calving in July through February, very low and well above average body weight (485 kg) was associated with a 2.2 times more frequent occurrence of injury (Table 1). The odds ratio for very low and well above average body weight for cows calving in March through June can be derived from Table 1 as 2.2/3.3 = 0.7. That is the association between injury occurrence and body weight in cows calving in the March to June was reversed compared to cows calving in July through February.

High milk yield as defined in Table 1 was associated with a 1.8 times more frequent occurrence of injury. Injury occurred 1.9 times more frequently among cows with a history of veterinary treatment for more severe cases of reproductive, metabolic, and infectious disorders. Dystocia per se was also positively associated with injury (associations not shown).

Injuries in lactations 2 to 9

Injuries of the degrees 1, 2, and 3 occurred among 6.1, 3.2 and 4.1 percent of the 832 cows in lactation 2 to 9, respectively. The final model included 2 two-factor interaction terms between month of calving and history of disease treatment and between season of year and sole ulcer. The association estimates in lactations 2 to 9 are presented in Table 2 and in Fig. 2.

The odds ratios for parity and comparison with Table 1 indicate that the risk of injury and the severity increased with lactation number in an almost linear fashion. The effects of season of observation and sole ulcer were very similar to those revealed in the first lactation; with January to March being the low-risk period and sole ulcer in fall being strongly associated with injury. Calvings in March through October were associated with a 2.1 times more frequent occurrence than in November through February, among non-diseased cows. Calvings in March through October were associated with an 11.3 (derived as 6.8/0.6) times more frequent occurrence than in November through February, among diseased cows. Disease defined as 1 or more treatments for any limb disorder had only a significant effect among cows calving in March through October (odds ratio can be derived from Table 2 as 6.8/2.1 = 3.2).

Injury occurred more frequently among cows examined early (before day 159) or late (after day 240) in lactation as indicated by the odds ratio value 2.4 in Table 2. Both low and high milk yield (defined i Table 2) were associated with a markedly increased occurrence of injuries (odds ratio = 3.2). Cut off points for level of milk yield differ in first and later lactations because categorization (see data editing section above) were performed within parity group. A strong association between low body weight and injuries was found but injuries also occurred more frequently among cows with body weight around the average. Estimates of this non-linear relation are not shown.

Initial graphical analysis revealed systematic changes in the distributions of the recorded degrees of injuries over the study period. The

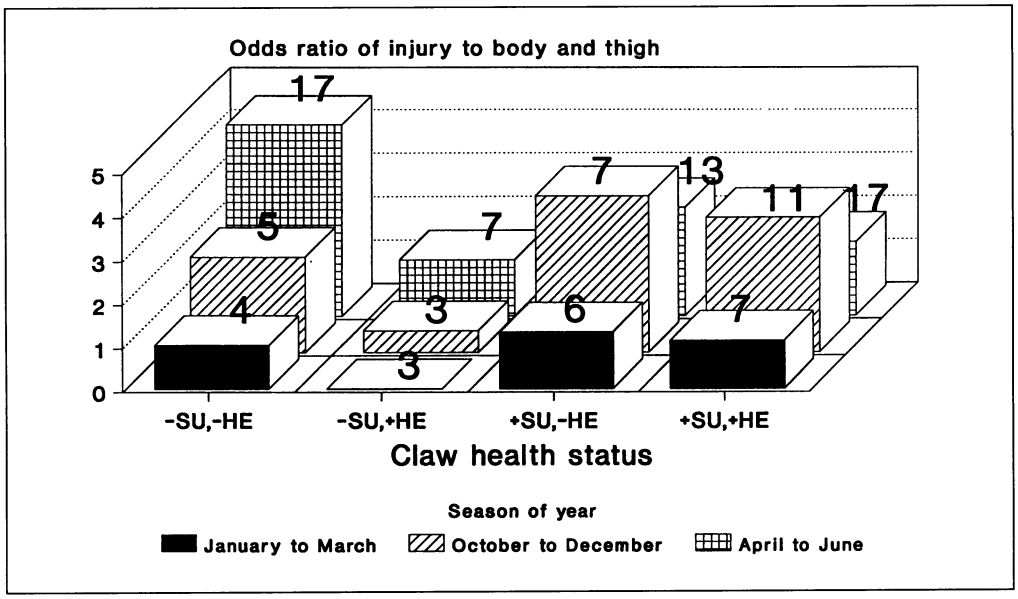

Figure 1. Associations between injuries on body and thigh of cows in lactation 1 and season of year, sole ulcer (SU, + or -) in one or more feet, and heel erosion (HE, + or -) in the fore feet. Odds ratio value of 1 indicates no association. Numbers on top of bars represent percentage of observations.

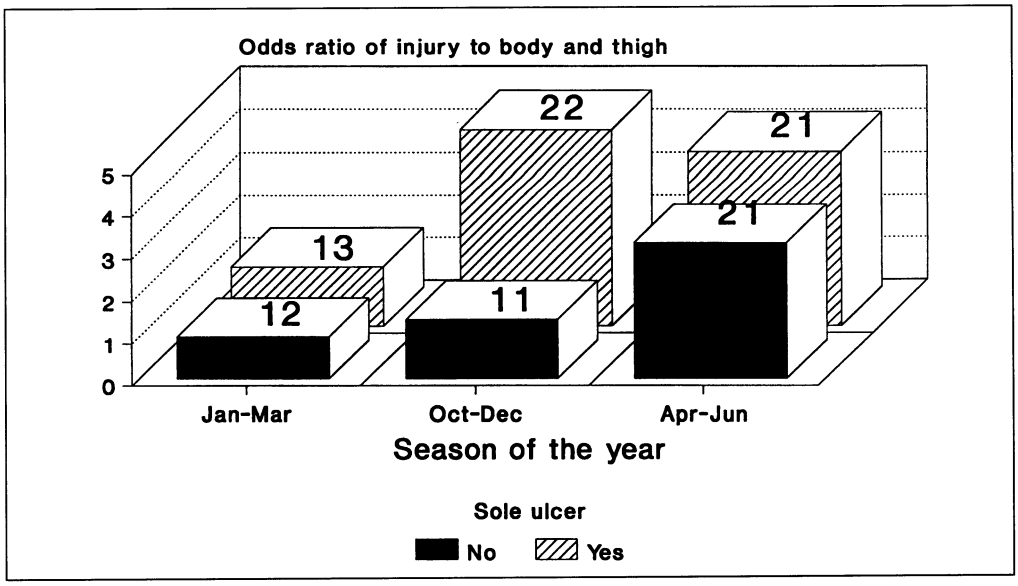

Figure 2. Associations between injuries on body and thigh of cows in lactations 2-9 and season of year, sole ulcer in one or more feet. Odds ratio value of 1 indicates no association. Numbers on top of bars represent percentage of observations.

association estimates of the herd-year of calving variable were highly variable in all models.

Discussion and conclusion

The purpose of this study was to evaluate whether the occurrence of injuries varied markedly according to "true" cow characteristics like parity and stage of lactation and other conditions of the cows (animal level risk factors). Obviously, factors like constructional details and management are very important risk factors too, but the effect of these herd level risk factors is expected to be eliminated by means of the inclusion of the herd-year of calving as a variable in the statistical models. The herd-year of calving variable provided separate estimates of the effects of each year in each herd (an interaction between herd and year of calving is assumed). Therefore, systematic "herd effects" are efficiently eliminated. Consequently, the effect of herd factors like housing system or grazing is not assessed in this analysis. However, with knowledge about associations among cow level risk factors and injuries the associations among such herd level factors and injuries could be validly and precisely estimated from a sample of dairy herds included in an ongoing monitoring scheme.

Associations with parity

This study clearly shows that the occurrence and severity of injury like many other health disorders increase with lactation number. These associations should probably be expected because of the duration of exposure to the surfaces of the housing system but culling of the cows most severely affected by injuries will often reduce the magnitude of such relations. Any scheme to monitor injury occurrence in cow populations should, however, take lactation number into account.

Associations with season

Seasonal factors clearly influenced the occurrence of injuries although in a rather complex manner. It appeared, however, that examinations performed in January to March were consistently associated with the lowest occurrence. These findings could be explained by less efficient herd management in April to June and in October to December. The workload is highest in the fall and spring (field work) when changes in the feed ration also occur more frequently. Consequently, the need for monitoring of individual cows increases and the available time to perform this task decreases in these periods. This could directly influence amount and cleanliness of bedding. With respect to management, the most stable season in general is the winter. Longer lying time may also have had a stronger effect in the summer and fall when the stalls are usually cleaned thoroughly, possibly making surfaces more abrasive for a period of time. Although bedding was used, concrete floors can be more abrasive for a period of time after cleaning.

The associations among month of calving and occurrence of injuries were more mixed and differed in first and later lactations. In general, calvings during the summer and fall appeared to be most at risk. One possible explanation for this pattern could be insufficient numbers of proper calving facilities in this period of time when a relatively larger proportion of calvings takes place. Such an explanation could in particular be valid for heifers of below average body weight which may be more disposed to difficult calvings.

The complexity of the associations between seasonal factors and injuries does call much attention to the factors comprising the strong seasonal effects which clearly must be controlled for in both experimental and observational studies. Calving season is also shown to

have a marked influence on milk yield (*Hindhede & Thysen* 1985) and claw health (*Enevoldsen et al.* 1991a & b). In a monitoring scheme some stratification on calendar as well as on lactational time appears mandatory.

Associations with stage of lactation
It is difficult to separate the effects of season of examination, season of calving, and stage of lactation in an observational study; in particular if calvings are not evenly distributed as was the case among first lactation cows in this study. This may explain why stage of lactation did not appear important in the model of injury occurrence in the first lactation. In later lactations injury occurred more frequently among cows examined early or late in lactation. Injuries could be acquired at the time of calving or susceptibility could be higher early in lactation because of the weight loss. The increased occurrence in late lactation could be spurious due to low numbers of cows but could also be a consequence of systematically delaying culling of cows in poor body condition (thus rendering them more prone to injury or being in poor condition due to injuries) to obtain a better price for slaughter. An efficient stratification on season of examination and season of calving would probably account for most of a possible stage of lactation effect in a monitoring scheme.

Associations with milk yield
High milk yield was associated with more frequent occurrence of injury in all parities. The most likely explanation is, that these cows lost more weight and consequently had more protruding parts on the body. Consequently, such cows demand more soft bedding. Among older cows low milk yield was also associated with a markedly increased occurrence of injuries. The association with low yield might be caused by injuries (or the conditions causing them) which reduced milk yield.

Associations with body weight
Low body weight was strongly associated with occurrence of injuries but the relation was non-linear as injuries also occurred more frequently among cows with body weight around the average. The latter association is difficult to explain. It could be spurious. As with most of the other associations, further studies with a more strict timing of examinations to avoid some of the potential biases is necessary to confirm the findings. These biases are discussed in detail elsewhere (*Enevoldsen et al.* 1990). However, some stratification on body weight or body condition is probably necessary in a monitoring scheme.

Associations with sole ulcers
The rather complex interaction between season and sole ulcer makes clear inferences difficult. However, the associations between season of year and sole ulcer were similar in first and later lactations, with January to March being the low-risk period and sole ulcer in October to December being strongly associated with injury. Because the occurrence of sole ulcer is also strongly influenced by seasonal factors, it is likely and definitely biologically plausible that sole ulcers and injuries share common causal factors. In conclusion, it appears that occurrence of sole ulcers should be taken into account in a monitoring scheme.

Associations with heel erosions
The variable heel erosion in the fore feet was included in this analysis because heel erosion in the fore feet was regarded as an indicator of damp, unhygienic conditions around the (-front) claws. Such conditions could also indicate a larger amount of bedding which would protect against contusions. The present find-

ings provide evidence for this hypothesis. No information about the amount of bedding and the hygienic condition for the *individual* cows were available.

Associations with disease treatments

This study indicates that limb disorders and severe diseases are associated with a higher frequency of injuries. It is reasonable to assume that severe cases of disease increased lying time and behavior of the animals thus increasing the risk of injury. Dystocia, per se, was also positively associated with injury.

The increased occurrence of injuries among cows calving in March through October with history of disease treatment - especially among cows treated for limb disorders - is difficult to explain unless it indicates that the disease cases are more serious or treated later or less efficiently (due to a greater workload?) during this period. Summer has previously been found to be positively associated with digital disorders (*Enevoldsen et al.* 1991a & b). Because disease treatment records are completely confounded with herd it does appear difficult to utilize such data in a scheme to point out »problem herds«. For monitoring within herd such data could be very useful. *Enevoldsen* (1993) discusses this issue in more detail.

Associations with other factors

Initial graphical analysis revealed systematic changes in the distributions of the recorded degrees of injuries over the study period. The herd-year of calving variable was forced into all models to take into account possible systematic changes in recording procedures that might have taken place in a study lasting 4 years. Including the herd-year also adjusts the estimates for factors like feeding, precalving preparation of heifers, genetic characteristics of the herd, disease treatment strategies, skills of claw trimmers, amount and type of bedding material, and shifts in farm personnel taking care of cows. Different habits with respect to management procedures and ability of different persons to observe and correct errors at an early stage varies and might have had an effect. The association estimates of herd-year of calving were highly variable in all models suggesting that extreme caution must be taken if comparison of different studies and years is done. This study and similar findings with respect to claw disorders (*Enevoldsen et al.* 1991a & b) suggest that in long term studies the effect of year must be taken into account in the analysis. Detailed descriptions of herd factors (stalls, hygiene etc.), incidences, and prevalences of the different digital disorders in each herd are given elsewhere (*Blom* 1981, *Østergaard* 1985, *Thysen et al.* 1985). For herd health management and research purposes it is very important to reveal and to provide estimates of such herd specific conditions with effect on the occurrence of injuries. The current estimates can provide an aid to setting up valid and precise monitoring systems that allows such estimates to be provided.

Acknowledgments

Computations supporting this research were performed on the Cornell Production Supercomputer Facility, which is supported in part by the National Science Foundation, New York State, and the IBM Corporation.

References

Blom J.Y: Trykninger og andre fysiske skader på malkekøer ved forskellig staldindretning. (Injuries on dairy cows related to housing). Report 515 (Dairy production systems XXI). In: Østergaard V. & Hindhede J (eds.): Natl. Inst. Anim. Sci., Denmark. 1981, 73-104.

Enevoldsen C: Sundhedsstyring i mælkeproduktionen. (Dairy herd health management). PhD.-thesis. Royal Veterinary and Agricultural University, Copenhagen, Denmark. 1993, 138 pp.

Enevoldsen C, Gröhn Y.T. & Thysen I: Physical injuries in dairy cows: Associations with season, cow characteristics, disease, and production. Pages 133 to 144 In (Thrusfield M (ed.)): Proceedings from the annual meeting of Society for Veterinary Epidemiology and Preventive Medicine, Belfast, April 4-6. 1990. 189 pp.

Enevoldsen C, Gröhn YT Thysen I: Sole ulcers in dairy cattle: Associations with season, cow characteristics, disease, and production. J. Dairy Sci, 1991a. *74*. 1284-1298.

Enevoldsen C, Gröhn YT, Thysen I: Heel erosion and other interdigital disorders in dairy cows: Associations with season, cow characteristics, disease, and production. J Dairy Sci, 1991b. *74*. 1299-1309.

Ewbank R: Animal Welfare: Is an epidemiological approach possible? In: Thrusfield M (ed) Proceedings from the annual meeting of Society for Veterinary Epidemiology and Preventive Medicine, Edinburgh, April 2-4. 1986, 92-96.

Hagenlocher H, Schroer T: Wirtschaftliche Bedeutung, Vermeidung und Behandlung von Hautschaden beim Rind (Importance, precention, and treatment of skin lesions in cattle). Der Praktische Tierarzt, 1990, *71*, (12): 5-23.

Hindhede J, Thysen I: Milk yield and body weight gain in different housing systems for dairy cows. Pages 139 to 181. In (Østergaard V (ed.)): Report 588. Staldsystemets indflydelse på malkekoens sundhed, reproduktion, ydelse og tilvækst samt mælkeproduktionens økonomi (The effect of dairy cow housing systems on health, reproduction, production, and economy). Natl. Inst. Anim. Sci., Denmark. 1985, 139-181.

Smedegaard H.H: Contusion of the Sole in Cattle. The Veterinarian, 1964a. 2: 119-139.

Smedegaard H.H: Foot rot and chronic foot rot in cattle. The Veterinarian, 1964b. 2: 299-307.

Thysen I, Blom JY, Nielsen K: Foot, leg, reproductive, digestive, and metabolic disorders in dairy cows in different housing systems. In: (Østergaard V(ed.)) Rep. 588. Staldsystemets indflydelse på malkekoens sundhed, reproduktion, ydelse og tilvækst samt mælkeproduktionens økonomi (The effect of dairy cow housing systems on health, reproduction, production, and economy). Natl. Inst. Anim. Sci., Denmark. 1985,85-102.

Webb NG, Nilsson C: Flooring and injury – An overview. In (S.H. Baxter, M.R. Baxter & J.A.D. MacCormack, (eds.)). Farm Animal Housing and Welfare. M. Nijhoff for the Commission of the European Communities, Boston, 1983. pp 226-259.

Østergaard V: Experimental housing systems for dairy cattle. Goals, materials, and design. Pages 10 to 37 In (V. Østergaard, (ed.)): Report 588. Staldsystemets indflydelse på malkekoens sundhed, reproduktion ydelse og tilvækst samt mælkeproduktionens økonomi (The effect of dairy cow housing systems on health, reproduction, production, and economy). Natl. Inst. Anim. Sci., Denmark. 1985, pp 10-37.

Sammendrag

Trykninger på krop og lår af malkekøer: Sammenhænge med sæson, klovsundhed, sygdomsbehandling og andre ko-karakteristika.

En epidemiologisk undersøgelse blev gennemført i 18 malkekobesætninger med formålet at karakterisere de grupper af køer, hvor hudlæsioner på krop og lår forekom hyppigst. Data blev analyseret med multivariabel logistisk regression. De epidemiologiske mønstre var forskellige i første og senere laktationer. Første laktation: Hudlæsioner forekom blandt 7,7% af 1793 køer i første laktation. For størstedelen af køerne var såleknusninger associeret med læsioner, mens forekomst af balleforrådnelse var negativt associeret med læsioner. Kropsvægt var associeret med forekomst af læsioner, men associationen varierede med kælvningsmåned (vekselvirkning). Læsioner forekom hyppigst blandt højtydende køer. Svære reproduktions-, metaboliske og/eller infektiøse lidelser var associerede med læsioner. Senere laktationer: Hudlæsioner forekom blandt 13,4% af 832 køer i anden og senere laktationer. Sværhedsgraden af læsioner øgedes med alderen. Læsioner forekom mindst hyppigt ved undersøgelserne foretaget om vinteren men hyppigst blandt køer med såleknusninger. Kælvning i marts til oktober var associeret med læsioner, specielt når køerne også var behandlet for lemmelidelser. Flest tilfælde af læsioner blev observeret tidligt eller sent i laktationen eller blandt højtydende og meget lavt ydende køer.

(Accepted June 30, 1994).

Reprints may be requested from: C. Enevoldsen, National Institute of Animal Science, P.O. Box 39, DK-8830 Tjele, Denmark.