

Lameness Detection and Foot Lesions Identified during Hoof Trimming in Lactating Holstein Friesian Cows

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Abstract

The present descriptive study was designed to identify the type of foot lesions found in lame dairy cows and to describe the distribution of foot lesions between front and hind limbs and lateral and medial claws. A total of 379 lactating Holstein Friesian cows were included in this study. All cows were scored for locomotion using a scale from 1 (normal) to 5 (severely lame) based on gait and posture. Lame cows were defined as having locomotion score (LS) of 3 or 4. Each lame cow was properly restrained in trimming chute and each foot was examined for any lesion using Dutch 5 steps method. Lesions were identified in 231 cows. Infection type lesions were diagnosed in 52 cows (22.5%) and non-infection type lesions were diagnosed in 179 cows (77.5%). A total of 377 lesions were identified and the number of lesions recorded per cow ranged from 1 to 2 (median 1.6). Sole haemorrhage (SH), white line disease (WLD) and digital dermatitis (DD) made the majority of lesions. A higher mean number of DD, interdigital necrobacillosis (IN), WLD, and toe ulcer (TU) per cow was found in the ≥ 3 lactation cows compared with 1st or 2nd lactation cows. Increasing parity was associated with an increasing trend in mean number of infections diagnosed per cow. A higher proportion of cows was diagnosed with lesions on the hind limbs compared with front limbs (198 vs 33 cows). Fifty three lesions were found on the front limbs and 324 lesions were on the hind limbs. The hind lateral and medial claws were affected by 234 and 50 lesions respectively (72.2% vs 15.4%). Inspection of foot lesions as a routine management practice facilitates earlier identification and treatment of lesions enhancing herd productivity and welfare.

Keywords: Lameness, foot lesions, Dairy cows, foot trimming.

1. Introduction

Lameness has been identified as the most costly health problem of dairy cows [1], following mastitis and reproductive failure. Lameness indicates pain or discomfort during locomotion and is characterized by change in gait or an irregularity of the walking pattern. Lameness is most often caused by claw and/or leg disorders reflecting the attempt of the cow to reduce the amount of weight bearing on the affected limb. Thus, by reducing cow's mobility overall health and welfare are impacted [2]. According to [3], 80-

90% of causes of lameness in cattle are located in the distal limb. Claw disorders are most frequently in the first 3-5 months post-partum (PS). In studies conducted in North America the main causes of lameness were sole ulcers, white line disease, toe ulcers, digital dermatitis, foot rot and thin soles [4-6]. In a study conducted in New Zealand the main causes of lameness were white line disease (42%), sole injury (29.1%), axial wall lesions (13.1%), footrot (8.3%), sole ulcers (1.4%) in the 3,967 lame cows and heifers [7]. Becker et al., (2014) [8] evaluated risk factors associated with foot lesions and lameness in Swiss dairy cows. The risk of being lame was increased in cows affected by digital dermatitis heel-horn erosion, interdigital hyperplasia, sole ulcer, deep laceration, double sole and severe hemorrhages. Similar

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results were reported in Danish Holstein dairy cows [9].

Lameness has a major effect on milk production [3], negative impact on reproductive performance [10] and an increased risk of culling [11]. Causes of lameness on dairy farms range from those related to individual cow to environmental factors. The effect of each factor may vary [12].

To identify lame cows it is necessary to understand the parameters that define a normal gait. Measures involving association between limbs, stride movement in footfall patterns and limb-to-claw movements have been used in describing animal gait. A stride incorporates three major features: walking, decisive steps and specific direction [13]. Stride can be seen as a vector quality based on its distance and directional components [14]. In cows, stride ends up in the shortening of the limb and flexion of the joint when the hip, knee, hock and digital flexors are lifted above ground. Various gait characteristics such as stride length, asymmetrical steps, speed and weight distribution during cows' locomotion has been employed in lameness detection [15].

Alterations in Posture and Presentation of body movements are common in lame cows. The presentation of an ached back posture either at still or during locomotion has been associated with lameness in dairy cows [16]. Also, head bobbing in the form of their nodding or vertical movement, in consonance with the moment the claws touch the ground was reported as typical feature of lameness [15].

Lame cows in an attempt to reduce pain, redirect their body weight to the unaffected limb [17]. According to Pastell [18] more weight is often transferred to the healthy hind limbs if lameness occurs symmetrically in the front limbs.

Claw lesions remain the major causes of lameness in dairy cattle, but hock lesions and injuries are becoming a persistent problem in intensively managed dairy farms [19].

The objectives of this descriptive study were to identify the type of foot lesions found in lame dairy cows, and to describe the distribution of foot lesions between front and hind limbs and lateral and medial claws.

2. Materials and methods

The data used for this were recorded during lameness scoring by farm veterinary personnel at

Agricultural Research and Development Station (ARDS) Simnic-Craiova, Romania using a locomotion scoring.

Locomotion scoring is a 5-point system based on both gait and posture: 1 = normal; 2 = mildly lame (the back of cow is slightly arched when walking); 3 = moderately lame (the back of cow is arched when both standing and walking; the cow walks with short strides in one or more legs); 4 = lame (the lame cow can still bear some weight on the affected foot); 5 = severely lame (the back of cows is arched and the cow refuses to bear weight on the affected foot and remains recumbent). Lame cows were defined as having locomotion score (LS) of 3, 4 or 5. As the cows were leaving the milking parlour after morning milking; the entire herd was visually assessed for lameness. Data recorded for each case are presented in table 1.

Hoof trimming was done as per standard procedure and different foot lesions were observed in all animals. Different foot lesions were observed in all the lame cows ($LS \leq 3$) and in non-lame cows (LS 1 and 2).

Table 1. Data recorded for each case of lameness detection

Data	Definition
Date	Date cow or heifer detected
Lactation	1, 2 and ≥ 3
Foot	Left or right, fore or hind
Claw	Medial or lateral
Disease	As diagnosed
Sub category	Further information on the lesion, specific to that lesion

Each lame cow was properly restrained in trimming chute and each foot was examined for any lesion using Dutch 5 steps method: (1) Trim toe length; 2) Match untrimmed claw length/level; (3) Model (dish) out sole ulcer site 4) Relieve weight off painful claw and 5) Remove loose/under run horn and hard ridges in high risk zones) steps 1 to 3 are functional trimming and steps 4 and 5 are corrective (Therapeutic) trimming. Some of the following measurements can be done after elevation of the hooves in trimming chute: toe length (cm) from coronary band to the toe tip; dorsal hoof angle measured between dorsal hoof wall and sole line: heel height (cm) from coronary band in toe region to the ground level; heel height (cm) from coronary band in heel region to the ground level and heel height

to toe length proportions (%). Definitions of foot lesions are presented in table 2.

Table 2. Definitions of foot lesions (adapted from Greenough [20] and Tadich [21])

Foot lesions	Definition
1) Digital dermatitis (DD)	Proliferative inflammation lesions which initially looks like a raw, red, oval ulcer on the back of the heel
2) Interdigital necrobacillosis (IN)	Acute necrotizing inflammation of the interdigital skin and understanding tissues. The primary bacterial agent is <i>Fusobacterium necrophorum</i> .
3) Interdigital hyperplasia (IH)	Fibrous proliferation of the interdigital skin causing a mass that protrudes between the claws.
4) Heel horn erosions (HHE)	Pits and pockmarks, with parallel horizontal grooves on the bulbs of the heel.
5) Sole haemorrhage (SH)	Hemorrhagic discoloration covering $\geq 50\%$ of the sole are a smaller area with deep intense color.
6) Sole ulcer (SU)	Circumscribed loss of the sole horn exposing the corium of the solar surface located in the region of the bulb junction, usually nearer the axial than abaxial margin.
7) White line disease (WLD)	Separation of the wall horn from the sole horn as a result of damage in the white line region.
8) Double sole (DS)	One sole is present while a new sole grows beneath, or two soles separated by a space.
9) Toe ulcer (TU)	Focal area of necrosis or an abscess located at the tip of the claw, undermining the sole horn
10) Axial wall fissure (AWF)	Deep fissure on the axial surface of the claw, parallel to the dorsal wall.
11) Vertical wall fissure (VWF)	Vertical fissure of the wall horn, usually located on the dorsal or dorsolateral aspect of the claw.
12) Horizontal wall fissure (HWF)	Fissure of the wall horn parallel to the coronary band.
13) Long toe (LT)	Length of the dorsal aspect of the claw ≥ 8 cm and angle of the dorsal wall of the claw $< 50^\circ$.
14) Interdigital dermatitis (ID)	Inflammation of the interdigital skin without extension to deeper tissues.

Lesions were classified as infections or noninfectious causes of lameness. Data were collected over the period from December 2016 to December 2020. A total of 379 lactating Holstein Friesian cows were included in this study.

Statistical analysis

The data were entered into Microsoft Excel computer program 2007. STATA Version 14 was used to summarize the data descriptive statistics were used to express the results.

3. Results and discussion

Overall, 9.7% (n=37), 71.5% (n=271), 12.1% (n=46) and 6.6% (n=25) cows were having 1, 2, 3

and 4 locomotion score, respectively. Lesions were identified in 231 cows (60.9%) and lesions were absent in 148 cows (39.1%). Infection type lesions were diagnosed in 52 cows (22.5%) and non-infection type lesions were diagnosed in 179 cows (77.5%).

A total of 377 lesions were identified, and the number of lesions recorded per cow ranged from 1 to 2 (median 1.6).

Seventy five (19.9%) infections lesions and 302 (80.1%) non infection lesions were recorded (table 3).

Table 3. The number of cows diagnosed with each lesion and the total number of lesions

	Infection lesions							Non-infection lesions							Total
	DD	ID	IN	HHE	SH	SU	WLD	DS	TU	AWF	HWF	VWF	LT	IH	
Cows	32	4	4	12	62	12	48	8	9	10	2	18	6	4	231
Lesions	50	4	5	16	122	18	80	14	16	18	2	18	9	5	377

SH, WLD and DD made the majority of lesions (respectively accounting for 32.4%, 21.2% and

13.3% of all lesions recorded). The feet of 22 (9.5%) 1st lactation, 44 (19%) 2nd lactation and 165 (71.4%) ≥ 3rd lactation cows were examined. A significantly higher mean number of DD, IN, WLD, TU per cow was found in the ≥ 3rd lactation cows compared to 1st lactation cows or 2nd lactation cows.

A higher mean number of S.U. lesions per cow (2) was found in the 1st lactation and in the 2nd lactation cows, compared with to ≥ 3rd lactation cows (1.25; table 4). Increasing parity was associated with an increasing trend in mean number of infections diagnosed per cow (table 4). The mean number of DS, AWF, HWF, VWF, LT and IH per cow were found only in ≥ 3rd lactation cows (table 4). The distribution of lesions between the front and hind limbs and the lateral medial claws in shown in table 5.

A higher proportion of cows was diagnosed with lesions on the hind limbs compared with front limbs (1.98 vs. 33 cows; 85.7% and 14.3% respectively). In the front limbs 26 cows (78%) had lesions on medial claw. In the hind limbs 119 cows (60%) had lesions on lateral claw (table 5).

Fifty three lesions (14%) were found on the front limbs 324 lesions (86%) were found on the hind limbs. The hind lateral and medial claws were affected by 234 and 50 lesions respectively (79.2% and 15.4%).

Somers et al., [22] found a higher number of claw disorders in zero-grazing compared to grazing cows. Past time grazing of cows tends to decrease the risk of DD and SU compared to housed dairy cattle [23]. Somers and O’Grady [24] reported that ID, IN and HF lesions were not diagnosed in any of the examined feet. The ID and IN lesions are associated with unhygienic underfoot conditions, that lead to prolonged exposure of the interdigital skin to slurry [20].

Inspection of foot lesions as a routine management practice facilitates earlier identification and treatment of lesions enhancing herd productivity and welfare.

Understanding the type, frequency and distribution of foot lesions will provide insight into their epidemiological background and potentially lead to their identification of trends in

the presence of foot lesions and whether they change over time.

The foot lesions data recorded in this study provide useful information for developing effective foot health programs at the herd level.

Table 4. The mean number of lesions per cow across 3 lactation group of cows*

	1 st Lactation n = 22	2 nd Lactation n = 44	≥ 3 rd Lactation n = 165	One – way ANOVA p – value
Infections	1.00 ^a	1.21 ^a	1.65 ^a	0.04
Non – infections	1.87 ^b	1.93 ^a	1.29 ^a	0.03
DD	1.00 ^a	1.25 ^a	1.72 ^b	0.03
ID	0	0	1.00	0.14
IN	1.00 ^a	1.00 ^a	2.00 ^b	0.02
HHE	1.00 ^a	1.2 ^a	1.60 ^b	0.04
SH	2.00	1.9	2.00	0.50
SU	2.00 ^b	2.00 ^b	1.25 ^a	0.05
WLD	1.00 ^a	0	1.68 ^a	0.05
DS	0	0	1.75	0.84
TU	1.00 ^a	0	1.87 ^b	0.03
AWF	0	0	1.80	0.89
HWF	0	0	1.00	0.45
VWF	0	0	1.00	0.84
LT	0	0	1.50	0.88
IH	0	0	1.25	0.82
Mean	1.63	1.70	1.61	0.89

* First and second lactation cows were analyzed in separate groups. Third and higher (≥ 3) lactation cows were combined into one group.

a and b denote a significant (p < 0.05) difference in the mean number of lesions per cow, for that specific lesion between the different lactation groups.

Table 5.

	Cows	Lesions
Front limbs –	No	33
	% lateral only	6.2
	% medial only	78
	% lateral + medial	9.2
	% other	6.6
Hind limbs -	No	198
	% lateral only	60
	% medial only	3
	% lateral + medial	33.3
	% other	3.7

4. Conclusions

Locomotion score can be reliably used to identify clinical lameness in dairy Holstein Friesian cows.

Lesions classified as infections causes of lameness were DD, ID, IN and HHE.

Lesions classified as non-infection causes of lameness were SH, SU, WLD, DS, TU, AWF, HWF, VWF, LT and IH.

This data set provides a comprehensive overview of the lesions causing lameness in dairy cattle.

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