

THE MOST SIGNIFICANT PREDISPOSING FACTORS AND CAUSES OF LAMENESS OF DAIRY COWS

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Abstract

Lameness is considered as the most important productivity, health and welfare problem in dairy cattle. During last 20 years, occurrence of lameness increase continually, and now, on certain dairy cattle farms this syndrome appears at more than half of animals at least once a year. It is regarded among the costliest diseases in dairy industry along with mastitis and fertility problems due to impaired milk production, impaired fertility and increased risk of culling. Two the most significant causes of lameness are subclinical laminitis and digital dermatitis. There are many intrinsic and extrinsic risks for lameness. Intrinsic risks for lameness include season, gestation and stage of lactation, previous disease and parity. There is also a genetic determined intrinsic risk for development of hoof lesions. According to literature data there are six key external risks areas and the associated lameness that we can consider when attempting to reduce lameness in dairy cows: cow comfort (maximising lying times, comfortable lying surface, good walking and standing surfaces), cow hygiene (dry environment, slurry free environment, good herd biosecurity), social and physical integration for heifers and dry cows, cow flow on the farm (good routes around buildings, parlour, to pasture, to feed), diet (macronutrients, micronutrients), correct routine professional functional preventive hoof trimming.

Introduction

Lameness is considered as the most important productivity, health and welfare problem in dairy cattle. Investigations of lameness in dairy cattle have high health and economic significance. It is regarded among the costliest diseases in dairy industry along with mastitis and fertility problems (Hernandez *et al.*, 2000) due to impaired milk production (Warnick *et al.*, 2001; Juarez *et al.*, 2003, Sogstad *et al.*, 2007), impaired fertility (Hernandez *et al.*, 2001; Sogstad *et al.*, 2006) and increased risk of culling (Esslemont and Kossaibati, 1997; Booth *et al.*, 2004). When apparent, lameness is the most representative animal-based indicator of welfare in dairy cattle (Whay *et al.*, 2003, Hristov *et al.*, 2008).

During last 20 years, occurrence of lameness increase continually, and now, on certain farms this syndrome appears at more than half of animals at least once a year (Vermunt and Greenough, 1994; Tadich *et al.*, 2010; Ward, 2001). Certain authors found out that prevalence of lameness in different countries varies greatly, ranging between 1.2% in The Netherlands (Smits *et al.*, 1992) and 24.6% in USA (Espejo *et al.*, 2006), while according the

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Review paper

others, incidence rate varies between 6% and 42% (Alban *et al.*, 1995; Clarkson *et al.*, 1996; Manske, 2002; Manske *et al.*, 2002a; Dembele *et al.*, 2006).

Lameness could be very frequent on farms, contributing to decrease of milk production, even up to 30% (Bicalho *et al.*, 2008; Ettema *et al.*, 2007; Green *et al.*, 2002; Hernandez *et al.*, 2005; Hultgren *et al.*, 2004; Juares *et al.*, 2003).

On behalf of all presented data, the aim of this review paper is to perceive the most significant predisposing factors and causes of lameness in dairy cattle.

The most significant and predisposing factors and causes of lameness

Mostly, lameness is consequence of disturbed morphological and functional integrity of musculoskeletal system of locomotor apparatus. Locomotor apparatus diseases in dairy cattle have complex multicausal etiology, referring to certain classical and many other specific factors in intensive production. The occurrence rate on the most dairy farms is about 12-18%, and hooves deformities rate occurrence might be even more than 50% on certain farms. Having in mind this, economic losses conditioned by locomotor apparatus pathology has high significance, referring to premature culling, production decrease and treatment costs (Enting *et al.*, 1997). Lameness of dairy cows is caused by numerous mechanical insults or even more often, by combination of different long time acting predisposing factors and causes (Murray *et al.*, 1996; Manske, 2002).

There are many intrinsic and extrinsic risks for lameness. Intrinsic risks for lameness include season (MacCallum *et al.* 2002), gestation and stage of lactation (Knight, 2001; Green *et al.*, 2002), previous disease (Alban *et al.* 1995; Alban *et al.*, 1996; Hirst *et al.*, 2002) and parity (Hedges *et al.*, 2001; Hirst *et al.*, 2002;). There is also a genetic determined intrinsic risk for development of lesions (Boettcher *et al.*, 1998; Koenig *et al.*, 2005). According to Mülling *et al.* (2006) there are six key external risks areas and the associated lameness that we can consider when attempting to reduce lameness in dairy cows: cow comfort (maximising lying times, comfortable lying surface, good walking and standing surfaces), cow hygiene (dry environment, slurry free environment, good herd biosecurity), social and physical integration for heifers and dry cows, cow flow on the farm (good routes around buildings, parlour, to pasture, to feed), diet (macronutrients, micronutrients), correct routine professional functional preventive hoof trimming (Telezhenko and Bergsten, 2005; Hristov *et al.*, 2007).

The most significant factors influencing on locomotor apparatus disease in dairy cattle occurrence are: heredity, rearing conditions and nutrition (Knight, 2001; Murray *et al.*, 1996). It is considered that lameness occurrence could be related to genetic disposition, season, production intensity, as well as diseases, particularly related to metabolic disorders (Ward, 2001; Manske, 2002; Anon., 2009; Sanders *et al.*, 2009). The most significant rearing conditions influencing lameness occurrence rate are type and quality of floor, type and quantity of bedding material, lairs, hygiene conditions in barns, particularly moisture and slipperiness of the floors (Dippel *et al.*, 2009; Murray *et al.*, 1996; Vermunt and Greenough, 1994; Vermunt, 1999; Ward, 2001). Factors related to feed quality influencing on lameness occurrence rate, such as level proteins and minerals, were investigated. Sudden changes in diet to higher concentrate rations can cause a condition called acidosis in the rumen. Acidosis causes the release of chemicals into the blood stream, which then travel to the vessels of the hoof. These chemicals can gradually destroy the vessels supplying the hoof tissues with blood (Vermunt and Malmo, 2003; Anon., 2009).

Importance of well-timed hooves correction is emphasized in literature, as well as treatment of affected animals in initial phase of different forms of lameness, in order to

decrease production losses (Manske *et al.*, 2002, Vermunt i Greenough, 1994; Vermunt and Malmo, 2003; Ward, 2001; Sanders *et al.*, 2009). Hooves disorders are implicated in 90% of lameness in dairy cattle (Murray *et al.*, 1996). In the pathogenesis of hooves lesions are involved herd-level factors such as housing environment, management practices and nutrition, as well as cow-level factors including parity, stage of lactation, body weight and genetics (Koenig *et al.*, 2005; Vermunt and Greenough, 1994).

Scrutinizing all data related to dairy cows rearing technology leads to conclusion that locomotor apparatus diseases could be found in tied rearing system, particularly on short type of lying surface (Alban *et al.*, 1996; Anon., 2009; Dembele *et al.*, 2006; Murray *et al.*, 1996; Telezhenko and Bergsten, 2005; Vermunt and Greenough, 1994). On this type of lying surface any movement of the animal is limited on standing up and lying down, and step or two forward and backward. Situation is more complicated when behind short lying surface manure removal channel is not covered with slats, and cows stand by their hind limbs on the edge of channel risking falling in and hurting acropodium, or standing in the channel in unnatural poses, affecting body static, joints and tendons of entire locomotor apparatus, but particularly hind limbs. Consequently, acropodium is exposed to long lasting influence of faecal material inside of channel. Acropodium injuring happens especially during act of standing up on short lying surface, when it is almost inevitable hind limbs to slip into channel and traumatize the acropodium. Repetitive trauma of hooves, joints and tendons lead to chronicle deformities of acropodium, making cow less able or even disabled for further production (Anon., 2009; Hristov, 2002; Manske 2002). Further, very important moment in acropodium disease occurrence in tied system of rearing is not spending of hooves due to lack of movement. Average hoof horn grow per month is 7-10 mm. For complete renewal of frontal hoof horn 12 months is required, side part 8 months, 5 months for rear part and 3 months for sole part of the hoof. Relationship between growth and spent of hoof horn is not reciprocal. Hoof horn growth is independent of type of rearing and cow production type, and it is faster than hoof horn is naturally being spent. It grows permanently (approximately 1 cm per month), but if cow is deprived moving, hooves became overgrown (Anon., 2009; Hristov, 2002; Vermunt and Greenough, 1994; Vermunt, 1999).

As hoof horn grows to front and inside, the hooves gradually became longer, twist inside and up, sometimes crossing each other. It disturbs static of the body, burdening posterior body parts, soles and flexor tendons, mostly, with consequent inflammations, making not only moving, but standing, as well. With distortion of hoof horn in a change of position and mutual relations hoof bones, joint surfaces and the development of various inflammatory first, then a degenerative process, not only the hoof horn and joints. Due to severe pain when standing, animals most of the time spent lying, with reduction in appetite, poor feed utilization and weight loss, and consequent sudden decrease in milk production. When they are stable reared, hoof horn is less spent than of the cattle reared on pastures or extensive grazed (Anon., 2009; Hristov, 2002; Vermunt and Malmo, 2003). Knowing that lactation lasts 300-310 days, cow spent 10-11 months tied into stall, while hoof horn does not spent enough, it is obvious how massive overgrowth can be. On some farms, problem of overgrown hooves is even bigger, because dried cows are tied too. Situation on farm considerably improves when at least dried cows are reared free in lairs or pasture; in tied system of rearing hooves trimming and correction are applied at least twice a year (Anon., 2009; Hristov, 2002; Vermunt, 1999).

Lamely walk is followed by pain, decrease of appetite, decrease of milk production and body weight loos (Green *et al.*, 2002). Behaviour of limping cows is changing, they are restless when milking, lie down longer and intake of less feedstuff last longer (Juares *et al.*, 2003; Manske *et al.*, 2002). According literature, besides of decrease of milk production,

milk composition changes too (Bicalho *et al.*, 2008; Ettema *et al.*, 2007; Hernandez *et al.*, 2005; Hultgren *et al.*, 2004; Juares *et al.*, 2003).

Two the most significant causes of lameness are subclinical laminitis and digital dermatitis (Anon., 2009; Ward, 2001; Manske *et al.*, 2002; Murray *et al.*, 1996). Laminitis is an inflammation of the laminae and papillae of the hoof. It is a pathological disorder in the microvascular system of the corium, disturbing hoof tissue functions, especially those responsible for hoof horn generation. Laminitis could be subclinical or clinical, acute or chronic, depending on the expressed combined action of numerous causes of environment (Vermunt and Greenough, 1994). It is considered that lameness caused by subclinical laminitis and digital dermatitis is a basic problem in dairy cow production, not only for causing a decrease of milk production, but compromising the welfare status of cows as well (Juares *et al.*, 2003; Ward, 2001). The pathogenesis of laminitis is believed to be associated with a disturbance in the micro-circulation of blood in the corium which leads to breakdown of the dermal-epidermal junction between the hoof and the third phalanx. Rumen acidosis is considered to be a major predisposing cause of laminitis and presumably mediates its destructive effects through various vasoactive substances released in coincidence with the development of rumen acidosis. These vasoactive substances initiate a cascade of events in the blood vessels of the corium including hyperaemia (increased blood flow), thrombosis (clotting), ischaemia (loss of blood supply), hypoxia (lack of oxygen), and arterio-venous shunting (shunts which direct the flow of blood directly from artery to vein). The end result is oedema (swelling), haemorrhage (bleeding), and necrosis (tissue death) of corium tissues (Anon., 2009; Murray *et al.*, 1996).

Lameness prevalence can be quantified using a modification of a published lameness scoring system. Entire herds can be scored quite easily as they walk access lanes. Hoof health record systems have improved and are used by many professional hoof trimmers, which have made it easier to monitor the prevalence of digital dermatitis, laminitis, and other conditions (Frankena *et al.*, 2009; Tadich *et al.*, 2010). If laminitis is a herd problem, the primary risk factors of subacute ruminal acidosis, excess standing time on concrete, and replacement heifer management should be evaluated. Stall usage indexes are being developed to estimate time spent lying down in stalls (Whay *et al.*, 2003). Recent research is providing information on factors related to free stall design which influence lying time. Time in holding areas and parlours can be assessed, with an emphasis on the longest times for the last individual cows to come through the parlour (Whay *et al.*, 2003; Anon., 2009).

Hygiene and care of hooves

Hooves care deserves maximal attention for effective prevention of pathological changes. These changes reflect adversely on production traits of animal. In loose system of rearing, in lairs and pasture, when movement is allowed, hoof horn develops normally, because horn wearing was within the limits of growth (Dippel *et al.*, 2009; Espejo *et al.*, 2006). Hooves overgrow if cattle move less or mostly stand, when the growth of the horn in this case is greater than its wear (Anon., 2009).

If hooves are not cared properly numerous diseases of locomotor apparatus could develop. Care of hooves means series of hygienic measures which preserve physiology and static of hooves and limbs. These measures include correction of hooves due to limb static restoration and pathological changes rectification. One of these measures is planned herd hooves control, which should become part of production technology. It should be applied not only on farms with tied system of rearing, but in loose cow rearing in enclosed stalls as well (Manske, 2002, Manske *et al.*, 2002a; Vermunt, 1999).

Hooves checking and control in tied system of rearing has to be performed twice a year, and in loose system on slats without bedding up to 4 times per year (Hristov, 2002). During control, hoof cleanness, moisture and eventual pathological changes of hoof horn and hoof crown should be observed (Vermunt, 1999). Due to the prolonged retention of dirt, especially if cows reside continuously on wet floors and bedding, between the hoof and on its crown may develop inflammatory processes, which may cause the pain and limping. High humidity of the bedding could lead to moisturising and excessive softening of sole, allowing creation of painful bruises. Excessive drying of sole is also detrimental. It appears on the slats, as hoof horn cracking on lateral side of the hoof, disrupting hoof mechanism (Manske, 2002; Murray *et al.*, 1996).

Which measures will be undertaken depends on clinical findings (Hristov, 2002; Mülling *et al.*, 2006). Basically, these are measures which might be applied:

- Detail mechanical cleaning of the hoof and accumulated material removal, especially from interdigital space;
- Preventive footbaths and hooves washing and use of astringents in water (10% copper sulphate, 10-20% zinc sulphate, 5% formaldehyde) for too soft hoof horn; for too dry or cracked hoof horn washing or moisturising packs. Twice a month cows have to be driven through the footbath with the solution. Dimensions of the footbaths have to be 3.0 x 0.7 x 0.2 m, and they could be built in isolator, in front of the stall, or in front of parlour entrance. Same solution in this sized footbath could be used for 1500 cows. If necessary, solution could be sprayed;
- Appropriate hooves correction in order to remove overgrown or incorrect hoof parts and repair incorrect hoof spent and restoration of normal function of hoof mechanism. Hooves trimming should be performed with care, thoroughly at regular intervals: for tied cows 2 or 3 times a year, on pasture once or twice (in spring and autumn), first on front limbs on its inner and afterwards lateral hoof, then on hind limbs. To prevent incorrect trimming, hoof horn cracking or injuries, limbs must be fixed correctly. Hoof horn of front limbs is much drier than of the hind limbs, so they must be moisturized. Cow have to be fixed in fixation box or on table, enabling rolling cow down and changing position to horizontal, and prepare chisel, hammer, cutting nippers, scraping knife and hoof horn cutting knife. For stall reared cows hooves correction have to be performed at least twice a year, in spring and in autumn; and
- Medical treatment of pathological changes on the hoofs.

These hygiene measures and treatments can be performed on the deposits of cows or in special boxes. When cows are kept loose, these procedures are performed in the same yard for treatment, which is built near common milking parlour.

Conclusions

According presented data concerning the most significant predisposing factors and causes of dairy cows lameness, it could be concluded:

- Locomotor apparatus diseases have complex multicausal etiology, referring to certain classical and many other specific factors in intensive production. In the pathogenesis of hoof lesions are involved herd-level factors such as housing environment, management practices and nutrition, as well as cow-level factors including parity, stage of lactation, body weight and genetics;
- Occurrence rate on the most dairy farms is about 12-18%, and hooves deformities rate occurrence might be even more than 50% on certain farms;

- Economic losses conditioned by different pathology of locomotors apparatus are significant, considering incidence rate referring to premature culling, production decrease and treatment costs;
- Hooves care deserves maximal attention for effective prevention of dairy cattle lameness.

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NAJZNAČAJNIJI PREDISPONIRAJUĆI FAKTORI I UZROCI ŠEPAVOSTI MUZNIH KRAVA

Rezime

Šepavost se smatra najznačajnijim problemom proizvodnje, zdravlja i dobrobiti mlečnih krava. Tokom poslednjih 20 godina pojava šepavosti se kontinuirano povećava tako da se danas na određenim farmama ovaj sindrom pojavljuje na više od polovine mlečnih krava, najmanje jednom godišnje. Svrstava se u najskuplje bolesti na farmama mlečnih krava, zajedno sa mastitisom i problemima plodnosti zbog smanjenja proizvodnje mleka, remećenja plodnosti i povećanja rizika isključivanja krava iz proizvodnje. Dva najznačajnija uzroka šepavosti su subklinički laminitis i digitalni dermatitis. Na pojavu šepavosti utiču brojni unutrašnji i spoljašnji faktori rizika. Unutrašnji rizici za pojavu šepavosti obuhvataju sezonu, graviditet i fazu laktacije, prethodne bolesti i paritet. Postoje takođe i genetski determinišući unutrašnji rizici za razvoj lezija papaka. Prema podacima iz literature postoji šest ključnih spoljašnjih rizičnih kompleksnih faktora u vezi pojave šepavosti koje treba uzeti u razmatranje pri pokušaju da se smanji njena pojava kod krava: komfor krava (maksimiziranje perioda ležanja, udobne površine ležišta, odgovarajuće površine za kretanje i stajanje), higijena krava (suve površine, površine bez fecesa i urina, odgovarajuća biosigurnost stada), socijalno i fizičko integrisanje junica i zasušenih krava, kretanje krava na farmi (dobri putevi oko zgrada, ka izmužištu, na pašnjaku, pri ishrani), ishrana (makronutijenti, mikroelementi) i odgovarajuće rutinsko, profesionalno, funkcionalno, preventivno skraćivanje rožine papaka.