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Review article

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MONITORING AND PREVENTION OF LAMENESS IN A DAIRY CATTLE HERD

MONITOROWANIE I ZAPOBIEGANIE KULAWIŹNIE W STADZIE BYDŁA MLECZNEGO

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Streszczenie. Choroby racic u krów mlecznych utrzymywanych w intensywnych systemach produkcji występują równie często jak zapalenie wymion (*mastitis*), choroby układu rozrodczego i zaburzenia metaboliczne. Istotne jest stałe kontrolowanie zachowań i aktywności ruchowej krów oraz opracowanie obiektywnych metod oceny ich lokomocji i wczesnego wykrywania kulawizn. Kulawizny charakteryzują się wieloczynnikową etiologią obejmującą aspekty genetyczne i technologiczne, warunki utrzymania, a także, w znacznym stopniu, żywienie, pielęgnację i higienę zwierząt. Znajomość przyczyn powstawania chorób racic i metod profilaktyki oraz umiejętność szybkiej diagnostyki i leczenia kulawizn mogą przyczynić się do skrócenia procesu chorobowego i poprawy wyników produkcyjnych stada.

Key words: locomotion, motor activity of cows, hoof diseases, lameness, losses in production.
Słowa kluczowe: lokomocja, aktywność ruchowa krów, choroby racic, kulawizna, straty produkcyjne.

INTRODUCTION

The last 20 years have seen intensive growth of modern technologies associated with dairy cattle farming. These changes can be seen on farms where facilities have become modernized and tie-stall housing has been replaced by free-stall systems, as well as where an automatic milking system (AMS) has been introduced. This is linked to an increase in the animals' motor activity, which is not always spontaneous. In modern housing systems dairy cows move freely and regulate the intensity and frequency of movement. For this reason their behaviour and motor activity must be continually monitored and objective methods must be developed for evaluation of their locomotion and early detection of lameness.

LOCOMOTION IN COWS

During correct locomotion cows maintain a level back and their pelvic limbs are nearly in line with the thoracic limbs. In observing a moving cow we can distinguish three stages of locomotion: the weight-bearing phase, the forward phase (protraction) and the backward

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phase (retraction). During the weight-bearing stage, in the thoracic limb the tip of the hoof touches the ground first, followed by the rest of the sole. The entire limb is straightened. In the case of the pelvic limb, the heel touches the ground first, followed by the edge of the claw wall and its tip. The limb is not straightened out, but remains at an angle of 145–155 degrees from the ground. The second stage involves throwing the limb forward until it touches the ground. The final stage of movement is retraction, when the weight of the body is transferred forward and locomotion takes place, while the pelvic limb is thrown backwards (Greenough 2007; Gîscă 2012).

SUBJECTIVE EVALUATION OF LOCOMOTION

To evaluate locomotion in cows we can use a subjective 5-point scale according to Sprecher et al. (1997). According to this scale animals receiving a score of 1 are considered healthy. Such cows exhibit correct back posture at rest and in motion, and their limbs are correctly placed. Cows that limp slightly and arch their back a bit while walking receive a score of 2. When the animals are standing their back posture is correct. Cows with a locomotion score of 3 show moderate limping with an arched back both while walking and while standing. A shortened stride is observed as well. A score of 4 refers to cows with a permanently arched back and an impaired forward step in at least one limb. Animals with a score of 5 have a severe limp and a permanent pronounced arch of the back, and are extremely unwilling or even unable to transfer their weight onto the affected limbs. Moreover, they have difficulty rising from a recumbent position.

OBJECTIVE EVALUATION OF LOCOMOTION

Objective systems for evaluating locomotion in cows are usually based on automated computer systems with quantitative numerical values corresponding to a type of gait (Tasch and Rajkondawar 2004; Flower and Weary 2006; Rajkondawar et al. 2006; Pastell et al. 2008; Song et al. 2008; Martiskainen et al. 2009; Pastell et al. 2009).

Objective methods are more reliable and sensitive, but their practical and clinical use is limited by the high cost of using specialized devices in diagnostics and practice (Clayton and Schamhardt 2001; Wójcik and Rudziński 2014).

LAMENESS

Lameness is a crucial problem affecting production and welfare in modern dairy cattle farming. The welfare of cows is linked to ethical quality of production, and lameness is one of its main problems (Cook 2003; Whay et al. 2003; Cook et al. 2004; Cook et al. 2005; Hristov et al. 2008; Laven et. al. 2008; Cook and Nordlund 2009; Dippel et al. 2009). The comfort of cows while recumbent and in motion is of great importance as a factor limiting the occurrence of lameness. Lameness itself should not be treated as a disease, because a disease is a change in the structure or functioning of the organism, while lameness is merely the consequence of these abnormalities (Porter et al. 2010).

CAUSES OF LAMENESS

Four categories of causes of lameness in cattle can be distinguished. The first involves claw horn disruption, which causes haemorrhaging within the sole or white line, and in consequence the formation of ulcers and abscesses at these sites. The second category consists of inflammation due to infections of the skin of the toes and the claw horn. The third is classic laminitis, and the fourth group induces skin necrosis (Webster et al. 2005).

Lesions in the hoof and legs cause pain and discomfort when the animal stands or walks, which is manifested as lameness (Warnick et al. 2001). This leads to reduced milk production and increased culling of cows, which in turn generates significant economic losses. Hoof diseases in dairy cattle occur with the same frequency and can be just as costly as mastitis, diseases of the reproductive system or metabolic disorders (Nałęcz-Tarwacka and Jędrzejek 2012).

Over the last 20 years the incidence of lameness has continually increased, and it is currently observed at least once a year in over half of dairy cows (Vermunt and Greenough 1994; Hernandez et al. 2000; Tadich et al. 2010).

Lameness has a multifactorial aetiology including aspects of genetics, diet, and above all technology, associated with the housing and care of the animals, the equipment used on the farm and, to a significant extent, the animals' diet.

Table 1. Incidence of hoof diseases in cows according to various authors
Tabela 1. Częstość występowania chorób racic u krów według różnych autorów

Disease – Choroba	Incidence of disease Częstotliwość chorób [%]			
	Green et al. (2014)	Navarro et al. (2013)	De Frain et al. (2013)	Winkler and Margerison (2012)
Sole ulcer Wrzód podeszwy	38.68	6.84	21.05	17.14
Bruised sole Krwawe podbicia	12.98	10.00	1.43	28.57
Digital dermatitis Zapalenie skóry palca	10.00		47.67	22.86
White-line disease Choroba linii białej	8.28	16.32	17.26	5.71
Interdigital growth Międzyraciczak	4.50	6.84	0.19	2.86
Overgrown claw Skręcenie racicy/wyrośnięcie	3.11	3.68	1.08	–
Toe ulcer Wrzód czubka palca	1.79	3.68	2.61	–
Double sole Podwójna podeszwa	7.42	6.84	–	–
Hoof wall cracks Szczeliny w rogu	–	8.42	0.33	–
Heel erosion Nadżerki opuszki	–	6.84	0.04	-
Other Inne	13.24	26.86	8.34	22.86

Research in the United Kingdom has shown that the leading cause of lameness – in about 25% of cases – is bacterial infections, including anaerobic bacteria. Cases have most often involved ulcers (27%), white-line diseases (20%) and skin conditions (16%) (Amory et al. 2006).

Most lesions in hooves do not cause pronounced symptomatic lameness and thus can be difficult to detect when only the cow's gait and posture are evaluated (Manske 2002; Manske et al. 2002). In 70% of examined cows hoof disease was not detected until the hooves were trimmed (Green et al. 2002).

EXAMPLES OF NON-INFECTIOUS DISEASES

Sole ulcer (sole ulceration, Rusterholz ulcer, pododermatitis septica circumscripta) causes varying degrees of lameness, which may be weakly manifested if ulceration is present in both of the front or rear limbs. The most characteristic symptom, appearing before lameness, is bruising in the area typical for this disorder. However, this is not visible until about 6–10 weeks after its appearance, because only then does the bruising appear on the sole surface (Empel 1984; Greenough 2007).

Fig. 1. Sole ulcer
Ryc. 1. Wrzód podeszwy (E. Flis)

Heel erosion (slurry heel) – in the initial stage of the disease we can observe pits in the claw horn, which over time merge to form irregular, jagged edges. The most frequently observed symptoms are a deep V-shaped groove and dark discoloured horn in the affected site (Empel 1984; Greenough 2007).

Fig. 2. Heel erosion
Ryc. 2. Nadżerki opuszki (E. Flis)

White line disease (claw-wall separation) – an animal with this disease may walk with the limb abducted to the side, and while standing it may place its entire weight on the median claw (Empel 1984; Greenough 2007).

Fig. 3. White-line disease
Ryc. 3. Choroba linii białej (E. Flis)

Double sole – this disease usually affects all the hooves. Lameness is rarely observed, and the disease is detected during routine hoof trimming (Empel 1984; Greenough 2007).

Fig. 4. Double sole
Ryc. 4. Podwójna podeszwa (E. Flis)

INFECTIOUS DISEASES

Interdigital phlegmon (interdigital necrobacillosis, foot rot, foul-of-the-foot) – typical symptoms are sudden onset of lameness, interdigital swelling resulting in separation of the toes, secondary interdigital necrosis, and the presence of pus and a characteristic foul odour (Empel 1984; Greenough 2007).

Fig. 5. Interdigital phlegmon
Ryc. 5. Ropowica międzypalcowa (E. Flis)

Digital dermatitis (papillomatous digital dermatitis, Mortellaro's disease, heel warts, hairy footwarts, strawberries, strawberry heel) – a superficial ulceration of the hairless skin between the claws and the rear segment of the interdigital space. Lesions are small (about 0.5–1 cm), round or oval, red or brown, with a tendency to bleed, and often surrounded by a white margin (Empel 1984; Greenough 2007).

Fig. 6. Digital dermatitis (E. Flis)
Ryc. 6. Zapalenie skóry palca (E. Flis)

PREVENTION OF LAMENESS

Prevention of hoof disease should include improving the comfort of cows (maximized lying time, comfortable bedding surface, suitable surfaces for walking and standing), proper hygiene (a dry environment), social and physical integration of heifers and dry cows, ease of movement of cows on the farm (undamaged floor surfaces in barns and passage corridors), proper diet (macro- and micronutrients), and routine professional functional and preventive hoof trimming (Hristov et al. 2008).

Hoof trimming reduces the incidence of lameness, provided it is done correctly. One of the main functions of hoof trimming is to detect lesions in the early, subclinical stage before the appearance of clinical symptoms or serious damage. The second, extremely important function is to prevent hoof damage through early correction of pressure. This is one of the main factors reducing the risk of disease, regardless of the technique applied. Hoof trimming performed before calving reduces the incidence of lameness in comparison with cows in which the procedure is not performed (Grove-White 2004).

Hoof trimming twice a year reduces the incidence of sole ulcers by half. After properly performed hoof trimming the animal's weight is optimally distributed on all limbs, as well as within the hooves (Bergsten et al. 1998). According to Somers et al. (2005), cows whose time in the pasture or pen is limited, so that they are exposed to high moisture levels, have an increased risk of dermatitis. Both improving cleanliness and decreasing stocking density can be factors determining hoof health.

The quantitative and qualitative composition of feed rations plays a significant role in limb health in dairy cows. The use of feed rations based on fodder with high starch content causes rapid fermentation, leading to ruminal acidosis. This in turn affects the quality of the claw horn, which becomes softer and thus more likely to become worn down or cracked, increasing the risk of damage (Amory et al. 2006). High intake of non-fibre carbohydrates (NFC) accompanied by low intake of non-digestible fibre (NDF) lowers the pH of the rumen and causes secretion of histamine and endotoxins, which enter the bloodstream and damage the capillaries in the hooves, thereby producing horn tissue of lower quality (Bramley et al. 2008, Bicalho et al. 2009; Lean et al. 2013). A high level of protein increases the rate of growth of the hoof horn, which may lead to overgrowth and incorrect distribution of pressure, thereby causing a risk of hoof damage and prolonging lameness (Manson and Leaver 1988).

The supply of micro- and macronutrients and vitamins in the feed ration plays an important role in the quality of horn tissue. Deficiencies of sulphur, copper, zinc, selenium, manganese, cobalt, retinol or biotin, i.e. elements and vitamins taking part in keratin metabolism, reduce horn quality, having a detrimental effect on hoof health. Moreover, copper, zinc, selenium and manganese are components of antioxidant enzymes. Oxidative stress damages the capillaries in the hoof and thus interferes with the supply of oxygen and nutrients, leading to poorer horn quality (Tomlinson et. al. 2004; Seyrek et.al. 2008; Lean and Rabiee 2011; Al-Qudah and Ismail 2012).

Another important factor determining hoof health is flooring. The use of floors that ensure friction, and therefore better traction, is recommended to improve locomotion. Given a choice of hard or soft flooring, cows generally choose the soft option for both standing and walking. It is also recommended that the floor should be kept clean and that cows should not stay or move on wet or slippery floors soiled with excrement (Rushen and de Passille 2006; Flower et al. 2007; Telezhenko et al. 2008).

CONCLUSIONS

Lameness has a multi-factored aetiology including genetic and technological aspects, housing conditions, and to a large extent the animals' diet, care and hygiene. The occurrence and economic significance of lameness continues to be underestimated by farmers,

consultants and veterinarians. In this regard it is necessary to examine the herd, identify the scale of the problem and implement a comprehensive corrective programme including all known factors exacerbating the problem of lameness in the herd.

A necessary condition for combating lameness is improvement of animal welfare, including all of the following:

1) housing conditions
   - cow barns with adequate space for the cows to lie down and stand up and soft flooring encouraging them to lie down;
   - frequent cleaning and bedding of stalls, grates, floors and passages;
   - good ventilation, to keep floors and hooves dry;
   - unconstrained movement by the cows, to minimize standing and waiting time;
   - additional bedding in stalls for cows immediately after calving and for lame cows, to ensure additional comfort;
   - optimal stocking density;
2) care and hygiene
   - regular prophylactic hoof baths;
   - hoof trimming twice a year (prophylactic and ad hoc);
   - medical treatment;
3) diet
   - prevention of acidosis;
   - elimination or reduction of excess protein in feed rations;
   - increased supply of macro- and micronutrients (enriched salt licks).

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Abstract. Hoof diseases in dairy cows maintained in the intensive production system occur with the same frequency as udder inflammation (*mastitis*), diseases of the reproductive system and metabolic disorders. Behaviour and motor activity of cows must be continually monitored and objective methods must be developed for evaluation of their locomotion and early detection of lameness. Lameness has a multi-factored aetiology including genetic and technological aspects, housing conditions, and to a large extent the animals' diet, care and hygiene. Knowledge of causes of hoof diseases and prevention methods, as well as the ability to diagnosis and rapid treatment of lameness contribute to shorten the period of illness and improve production results.