The Veterinary Journal 192 (2012) 183–188

Contents lists available at ScienceDirect

The Veterinary Journal

journal homepage: www.elsevier.com/locate/tvjl

Quantitative assessment of physiological and behavioural parameters in healthy dairy cows evoked by transcutaneous electrical nerve stimulation of the udder

Franziska Kirscher [a,*], Rupert M. Bruckmaier [b], Claudia Spadavecchia [c], Katharina Friedli [d], Marcus G. Doherr [e], Claudia Syring [a], Adrian Steiner [a]

[a] Clinic for Ruminants, Vetsuisse Faculty, University of Berne, Switzerland
[b] Veterinary Physiology, Vetsuisse Faculty, University of Berne, Switzerland
[c] Department of Clinical Veterinary Medicine, Anaesthesiology Division, Vetsuisse Faculty of Berne, Switzerland
[d] Swiss Federal Veterinary Office, Centre for Proper Housing of Ruminants and Pigs, Tänikon, Switzerland
[e] Veterinary Public Health Institute, Vetsuisse Faculty, University of Berne, Switzerland

ARTICLE INFO

Article history:
Accepted 25 May 2011

Keywords:
Transcutaneous electrical nerve stimulation
Dairy cow
Subclinical mastitis
Pain
Distress

ABSTRACT

The pain and distress associated with transcutaneous electrical nerve stimulation (TENS) of the udder was evaluated by treating 20 healthy dairy cows with an electrical udder stimulator. This generated a sequence of pulses (frequency: 160 ± 10% impulses per second, duration 250 μs) and provided voltage ranges from 0 to 10 volts (±10%). Trials took place on three consecutive days, twice daily after morning and evening milking. Daily sessions were divided into two periods: (1) control (sham treatment) and (2) treatment (real treatment). Physiological (heart rate, respiratory rate, and plasma cortisol concentration) as well as ethological parameters (kicking, weight shifting, and looking backwards to udder) were defined as pain-indicating parameters and observed. Evaluation of data showed that only one parameter (kicking) was significantly increased during real treatment compared to sham treatment. It is concluded that the TENS therapy tested in this study can evoke changes in behaviour (increased kicking) consistent with an experience of pain in some cows.

© 2011 Elsevier Ltd. All rights reserved.

Introduction

Alternatives to antibiotics are being increasingly used in veterinary medicine. One such alternative is the use of a Dairy cell device (Dairy Cell Ltd.) to treat subclinical mastitis by applying electrical impulses to the udder. This device has been routinely used by dairy farmers in Switzerland (Krähenbühl, 2008), Germany (Liste, 2008), France (Vocoret, 2006) and Canada (Ferraro, 2005). However there has been limited evaluation of the welfare aspects of using such a device. The Swiss Animal Welfare Act (2005),[1] states that an animal's dignity and well-being are to be respected and protected. Dignity is considered to have been disregarded if the animal is hurt or frightened in any way (Chapter 1, Article 3a), and well-being is affected as soon an animal experiences unnecessary pain, suffering, harm or fear (Chapter 1, Article 3b).

Thus the term *well-being* describes the current mental and physical state of an animal and any assessment of it needs to be both physiological and psychological. *Physical well-being* is defined as the absence of disease and injury while *psychological well-being* usually includes a range of species-typical behaviours and freedom from distress (Swanson, 1995). *Distress* is a state in which an animal cannot escape from, adapt to or cope with the internal or external stressors or conditions it experiences, resulting in negative effects on its well-being (Alley et al., 2001).

Pain belongs to the group of external stressors, and was defined by Molony and Kent (1997) as 'an aversive sensory and emotional experience representing an awareness by the animal of damage or threat to the integrity of its tissues'. Pain changes an animal's physiology and behaviour to reduce or avoid damage. According to this definition, electrical stimulation can be painful. Previous studies (Lefcourt, 1982; Henke Drenkard et al., 1985; Aneshansley et al., 1992) have demonstrated that cows (like humans) are sensitive to electrical current. Cows may be even more sensitive due to much lower body impedance (resistance) – less than one-tenth of the body impedance of the human. The impedances reported for 60 Hz differed among cows and routes of administration of current and ranged from 250 to 3000 Ohm (Aneshansley et al., 1992).

Earlier studies have shown that pain caused by electrical stimulation can alter physiological variables such as heart rate (Gorewit and Scott, 1986; Lefcourt et al., 1986), blood pressure (Gorewit and Scott, 1986) and plasma cortisol concentration (Henke Drenkard

* Corresponding author. Tel.: +41 31 631 2344.
E-mail address: franziska.kirscher@knp.unibe.ch (F. Kirscher).
[1] http://www.admin.ch/ch/d/sr/455.

1090-0233/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.tvjl.2011.05.020

et al., 1985) and will provoke the expression of pain-indicating behaviour such as flinching, vocalizing or leg raising (Lefcourt, 1982). Mellor et al. (2005) suggested that behaviour is likely to be a useful indicator of noxious sensory input that leads to pain and distress if the behaviour is shown by treated animals but not observed in controls or in animals given effective analgesia. As for physiological variables, an increase in heart rate of a minimum of 20 beats per minute (bpm) reflects severe pain. This has been shown in bulls undergoing electroejaculation (Mosure et al., 1998), cows that were hot-iron or freeze branded (Lay et al., 1992) and calves that were hot iron dehorned without sedation or analgesia (Grondahl-Nielsen et al., 1999). In a state of pain, the respiratory rate as well as the heart rate increases (Henke and Erhardt, 2004).

Electrical impulses are used in medical research to produce pain stimuli. This procedure is established in mammals including horses (Spadavecchia et al., 2002) and dogs (Bergadano et al., 2009) as well as in humans (Reeves et al., 2004). The experiments are performed to test the potential of pharmacological or non-pharmacological management of pain; the severity of the experienced pain depends on the power and duration of electrical stimulation. However, electrical impulses are also used in physical therapy and in the management of pain. Areas where electrical stimulation have been used include muscle re-education, pain palliation and oedema reduction (Dunning and Lascelles, 2007).

Two modes of electrical stimulation have been used, namely, neuromuscular electrical stimulation (NMES) and transcutaneous electrical nerve stimulation (TENS). TENS is a commonly used non-pharmacological and non-invasive treatment for reduction of pain in humans (DeSantana et al., 2008). It is generally used in chronic pain conditions and is not indicated for initial management of pain (Nadler, 2004). Electrical stimulation to alter pain sensation involves the application of an electrical current to a sensory nerve. The most commonly employed TENS modalities in clinical pain are (1) high-frequency (>50 Hz), low-intensity (1–2 mA) TENS, delivered at sensory-level intensity but without motor contraction and (2) low-frequency (1–5 Hz), high-intensity (15–20 mA) TENS, with stimulation intensity producing motor contraction.

The hypothesised mechanism of action of TENS involves spinal (gate-control, frequency-dependent blockade) and supraspinal theories (i.e. release of endogenous neuromediators) and there may also be a placebo effect (Facchinetti et al., 1984; Han et al., 1991; Gao and He, 1996; White et al., 2001). Clinical studies evaluating the effect of TENS have produced inconsistent results in different species. Somers and Clemente (2006) showed that the development of mechanical and thermal allodynia is reduced after chronic constriction injury to the rat sciatic nerve by daily application of TENS. Data observed by Vance et al. (2007) showed that at both high and low frequencies TENS completely reversed the primary hyperalgesia of the inflamed knee joint in rats at 24 h and 2 weeks after induction of inflammation. In contrast, Reeves et al. (2004) found that TENS did not affect the ratings of pain intensity after electric shocks applied to humans.

Thus, applying electrical stimuli to the organic tissue of mammals can either be painful, pain-modulating or even analgesic. The present study was designed to evaluate whether cows receiving electrical impulses to the udder from the Dairy cell device (PS) that may deliver a maximal intensity of up to 5 mA suffer pain, and, if this were the case, to describe any changes in physiology or behaviour which might be evidence of pain experienced by the cows.

Materials and methods

The study was approved by the authorities for animal experimentation[2] of the Canton of Fribourg, Switzerland (Nr. FR 916/08).

Animals and housing

Twenty healthy lactating dairy cows (11 Red Holstein, 5 Holstein Friesian, 2 Holstein Friesian/Brown Swiss and 2 Red Holstein/Holstein Friesian), originating from the experimental herd of the Agroscope Liebefeld-Posieux Station (ALP) were used. The median parity of the cows was 4 (range, 1–8), the median age was 5.5 years (range, 3–10 years), and the median daily milk yield was 21.5 kg (range, 11.1–40 kg).

All animals were examined by the first author, and cows with teat or udder lesions, subclinical or clinical mastitis or signs of systemic disease were excluded. The California mastitis test (CMT) was used to detect subclinical mastitis. Cows with a positive CMT result in any quarter were also excluded. The selected cows were housed in a tie stall throughout the experiment, and were fed according to Swiss guidelines for feeding of dairy cattle.[3] They were milked twice daily by experienced milkers, using a DeLaval bucket milking unit.

Testing of the Dairy cell device

The device used in this study is described by the manufacturer as a 'Micro Current Electro Therapy Device'. It is powered by 9 V alkaline batteries. The manufacturer states that the PS generates a waveform comprising a sequence of high-frequency pulses (160 ± 10% impulses/s), with each impulse lasting for 250 μs, and that the provided voltage ranges from 0 to 10 V (±10%). The equipment we used was not equipped with a scale to display the voltage, so to enable an objective comparison between the treated animals, a scale was attached to the PS. The scale comprised 10 controller positions (positions 1–9 and maximum) and was designed around the button of the voltage controller. The gaps between the positions were identical.

The PS was tested in vitro in the experimental laboratories of the Institute of Physics of the University of Berne. Voltage output, frequency of given impulses and form of impulses were measured by a multimeter (105B Scopemeter Series 2, 100 MHz, Fluke). Each measurement lasted 8 min. To determine the intensity of current and voltage applied to the udders in vivo, 10 healthy lactating dairy cows were treated with the PS. Both electrodes were wrapped in wet felt; one electrode of the PS (cathode) was attached to the teat and the other (anode) to the quarter, according to the manufacturer's operating manual. The PS was always attached on the lateral surface of the right fore quarter at the crossing of two virtual lines (vertical line, elongation of the teat to proximal; horizontal line, halfway between the base of the teat and the base of the udder). Each treatment lasted for 8 min. The PS was tested stepwise at the 10 defined controller positions (1–9 and max.), while an ammeter and a voltmeter were included in the circuit. For each controller position, data for voltage and current output were measured and collected.

Preparation of the cows

All experiments were performed by the first author, who was familiar with the PS. Approximately 16 h before the trial started, each cow was restrained and the area over the right jugular vein was clipped and disinfected with 70% isopropyl alcohol and 5% povidone iodine. After disinfection, a 13 G indwelling catheter (Vygon) was inserted into the right jugular vein and sutured to the skin with three interrupted sutures, using USP 2 Supramid suture material (SERAG Wiessner). Catheter patency was maintained using a heparinised saline (Heparin 12 IU/mL 0.9% NaCl) flush solution, which was administered after each blood collection. Before the start of each trial, a commercial heart rate measuring system (POLAR S 610, Polar Electro) was attached to the cows, using electrodes fixed to a chest belt. To improve the quality of signals, hair was clipped and contact gel was applied between electrodes and skin.

Experimental protocol

Each cow followed the same experimental protocol. On three consecutive days, six identical sessions (session 1–6) took place 30 min after morning and evening milking. Each session comprised a collection of baseline (BL) values, control period (C) and treatment period (T). Collection of BL values included respiratory rate (RR), heart rate (HR) and blood samples for cortisol analysis. Within 5 min, the chest belt for continuous heart rate recording was fixed, BL values were collected and the PS was attached (both electrodes were wrapped in wet felt, one electrode of the PS (cathode) was attached to the teat and the other (anode) to the quarter) according to the manufacturer's instructions.

The PS was always attached on the lateral surface of the right fore quarter at the crossing of two virtual lines (vertical line, elongation of the teat to proximal; horizontal line, halfway between the base of the teat and the base of the udder). After another 5 min, in which the cow adapted to the equipment, Period C was started. This consisted of sham treatment (during which the PS was not activated for 8 min) and an observation time of 12 min with a disconnected PS. The experiment was continued after 5 min of adaption to the reattached PS and evaluation of the

[2] http://www.fr.ch/svet/de/pub/index.cfm.

[3] www.feed-alp.admin.ch.

Download English Version:

https://daneshyari.com/en/article/2464409

Download Persian Version:

https://daneshyari.com/article/2464409

Daneshyari.com