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Research Paper

Behavioural responses of pasture based dairy cows to short term management in tie-stalls

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ABSTRACT

Dairy cows in experimental grazing herds are often confined for metabolic measurements. The objective of this study was to establish effects of transfer from pasture, to tie-stalls in a metabolism house, then back to pasture, on lying behaviour and locomotion score of lactating cows: Holstein-Friesian (H, n = 16), Jersey (J, n = 16) and H × J (HJ, n = 16). Cows were transferred to tie-stalls on d 1 for 12 days, and were offered freshly cut ryegrass according to herbage allowance (HERB) and genotype: J low = 14; J high = 17; H and HJ low = 16; and H and HJ high = 20 kg DM/d. Lying behaviour was recorded on four days: −2, −1 (Pre-confinement), 3 (Early confinement), 10, 11 (Late confinement), 13 and 14 (Post-confinement) relative to transfer (d 1) using data-loggers, and was also video-recorded during the first 15 h. Locomotion score was recorded on days −4, −3, 12 and 16. No effects of HERB on lying variables were observed during the first 15 h in confinement, but J cows made more lying intentions (21.0 vs. 12.2; $P < 0.05$) and tended ($P = 0.07$) to have a shorter latency to lie. Cows spent less ($P < 0.001$) time lying in early confinement (07:22:29 h/d) than on any of the other occasions (9:12:50 h/d). Cows had more ($P < 0.001$) and shorter ($P < 0.001$) lying bouts in confinement than while at pasture. Low HERB cows spent more time lying than high HERB cows (09:54:55 vs. 09:09:33 h/d; $P < 0.01$). J had higher locomotion scores than H (9.2 ± 0.2 vs.7.8 ± 0.2; $P < 0.001$), and tended ($P = 0.09$) to have higher scores than HJ (8.5 ± 0.2) cows. Locomotion scores were lowest pre confinement, highest at turnout (d 12), and intermediate after that at pasture (d 16) (7.6 ± 0.2, 9.3 ± 0.2 and 8.6 ± 0.3, respectively; $P < 0.01$). On transfer to the metabolism house cows showed disrupted patterns of lying although daily lying time returned to levels similar to pasture by late confinement. Confinement also resulted in a short-term deterioration in locomotory ability, which although improving, was still evident 4 days following the cows return to pasture with Jersey cows being more affected than the other genotypes. These findings suggest that longer adaptation periods and temporary release to loafing areas may improve both the validity of data collected and cow welfare.

1. Introduction

Dairy cows in experimental grazing herds are often confined for days or weeks in 'metabolism stalls' (Pratt and Holdaway, 1942) for precise and/or invasive measurements (e.g. feed/water intake, faeces/urine/tissue collection, gaseous emissions) where they are generally tied or restrained by the neck (i.e. 'tie-stalls') (Powell et al., 2007; Pinares-Patiño and Waghorn, 2014). There is growing consensus in pharmacological research that behavioural and physiological alterations resulting from experimental conditions imposed upon animals could affect the validity of the experimental measures under investigation (Würbel, 2001; Wolfer et al., 2004; Würbel and Garner, 2007). There is little research in the area with regard to dairy cows.

The transition from pasture to tie-stalls involves several abrupt changes to cows physical and social environment. The most obvious change is in the cows' ability to move around. In a study by Veissier et al. (2008), cows tethered for one day increased the time spent walking by 40% and distance covered by 50% when they were released in a test arena. Space restrictions and stall partitions may restrict lateral movement and inhibit lying behaviour (Tucker et al., 2004), as can a

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change in the surface underfoot (Tucker et al., 2003; Fregonesi et al., 2007; Tucker et al., 2009). Social behaviour is also limited to restricted contact with adjacent cows. Nevertheless, cows can readily adapt to new management systems (Jago and Kerrisk, 2011; O'Driscoll et al., 2011), hence, it is possible that although the changes associated with tie-stalls compared to pasture may pose initial challenges, cows can adapt to the tie-stall environment.

Lying is a high priority behaviour for cows (Munksgaard et al., 2005), is considered a key indicator of cow comfort (Overton et al., 2002; Tucker et al., 2009) and an acute change to either duration of, or patterns of lying behaviour are likely indicative of an environment or circumstance that is posing a challenge to the cow (Fregonesi and Leaver, 2001). Housed dairy animals have an inelastic demand for lying of 12–13 h per day (Jensen et al., 2005). There is no equivalent information for cows at pasture. However, it is possible that the duration required for cows lying at pasture is slightly reduced given the more comfortable underfoot conditions among other reasons as discussed by O'Driscoll et al. (2015). Indeed, cows in intensive grazing systems typically lie for 9–10 h per day (Olmos et al., 2009; O'Driscoll et al., 2010; O'Driscoll et al., 2015). Cows at pasture show a circadian pattern of lying (Arave and Albright, 1981; Driscoll et al., 2010, 2011; Driscoll et al., 2010, 2011) and, in general, long lying bouts are associated with a good level of comfort (Ito et al., 2014).

The lying down movement in dairy cows involves physical displacement of the cow of up to 300% of back length (longitudinal movement), and 180% of hip width (lateral movement) (Ceballos et al., 2004). The behaviour is carried out with a relatively defined sequence of movements, described by Jensen (1999). Cows may be unable to easily adapt their movements in a restricted area, particularly if they are large relative to the size of the cubicle/tie-stall. Moreover, cows impact the ground with considerable velocity (2.20 m/s; Ceballos et al., 2004) during the lying down movement, and thus inappropriately sized, designed or bedded stalls could cause injuries which could be compounded by the negative effects of a lack of exercise on limb health (Gustafson, 1993; Keil et al., 2006). Hence restrictions to movement with regard to lying and walking, combined with the potential for injuries when lying, mean that cows previously accustomed to management at pasture may show impaired locomotory ability after a period of confinement in tie-stalls.

The primary objective of this study was to determine whether dairy cows' lying behaviour and locomotion score are affected by a short period of confinement in tie-stalls following transfer from pasture. We hypothesised that cows would show disrupted lying behaviour on introduction to the tie-stalls until they adapted to lying down in close confinement. We also expected that cows would have a different pattern of lying behaviour in tie-stalls compared to pasture, due to space restrictions and the change in underfoot surface. As a consequence of these changes, we expected to see evidence of impaired locomotory ability once the cows were released from the tie-stalls 12 days later. We used three dairy cow genotypes (Holstein-Friesian (**H**), Jersey (**J**) and Holstein-Friesian × Jersey (**HJ**)), which differ considerably in mature body size. We expected that smaller cows would adapt more readily to the tie-stalls.

2. Material and methods

The experiment was undertaken between July and October 2010 at the 'Moorepark' research farm complex, part of the Teagasc Animal & Grassland Research and Innovation Centre, Moorepark, Fermoy, Co. Cork, Ireland (52°09′N; 8°16′W).

2.1. Animals and treatments

Animals were selected from a herd of 135 spring-calving, multiparous lactating pregnant cows which were part of a larger experiment investigating the effect of genotype (H, J and HJ) and stocking rate (high, medium or low) at pasture. The cows were blocked on genotype, parity number, calving date and pre-experimental milk yield and randomly assigned to one of three stocking rates (Thackaberry et al., 2011). Stocking rate was determined according to genotype body size. Thus the high, medium and low stocking rates were 3.0, 2.75 and 2.5 cows/ha respectively for H and HJ cows, and 3.25, 3.00 and 2.75 cows/ha for J cows. In 2010, cows from the high and low stocking rate treatments were used to evaluate in vivo digestibility capabilities of the three genotypes (Beecher et al., 2014) which necessitated housing the animals in tie-stalls in the metabolism house at Moorepark. Animal and management details are described in detail in Beecher et al. (2014). Briefly, four replicate groups of 12 cows from the original herd were blocked according to stocking rate (high and low), genotype (H, J or HJ), pre-experimental body weight (502 kg (SD = 72.8)), parity (3.5 (SD = 1.20)) and days in milk (182 d (SD = 26.4)). Each replicate group included four cows from each genotype, and within each genotype two cows from each stocking rate. Cows were offered a high or low herbage allowance (**HERB**) that reflected the stocking rate treatment that had been applied at pasture according to their genotype: J low = 14; J high = 17; H and HJ low = 16; and H and HJ high = 20 kg DM/d. The experiment was replicated over time, i.e., replicate groups went through the experimental procedure consecutively. The cows had no prior experience of tie-stalls, but they had experience of loose housing with cubicles every winter (60–90 days from approximately November to February). Indoor winter cubicles (2.13 m × 1.19 m) were bedded with rubber mats and allocated at a ratio of 1:1 (O'Driscoll et al., 2009).

2.2. Animal confinement and management

After an average 192 (SD = 30.8) days at pasture, cows were transferred to tie-stalls in the metabolism house after the morning milking (approximately 07:00 h), i.e., on d 1. The metabolism house had 12 tie-stalls (1.35 m long × 1.20 m wide) in which cows were tied or tethered individually by the neck before 12:00 h. The chain tethers were joined through a metal ring to a 1.10 m fixed vertical chain that allowed cows to freely move up and down (Fig. 1). The floor of the tie-stalls was covered with 3 cm deep rubber mats. Stall dividers were made from solid plastic (1.2 m high) (Fig. 1). Cows remained in the tie-stalls until d 12, at which point they were returned to pasture after the morning milking. Each tie-stall was provided with an automatic drinker and water was available ad libitum (Fig. 1). Cows were offered freshly cut grass (*Perennial ryegrass* L.) twice daily at 8:00 h and 14:00 h, at a high or low HERB that reflected the stocking rate treatment that had been applied at pasture. Herbage dry matter content was estimated daily by drying a daily herbage sample at 95 °C for 15 h. Cows were milked twice daily at 08:00 h and 16:00 h in the tie-stalls. Herbage chemical composition, animal production and digestibility results are

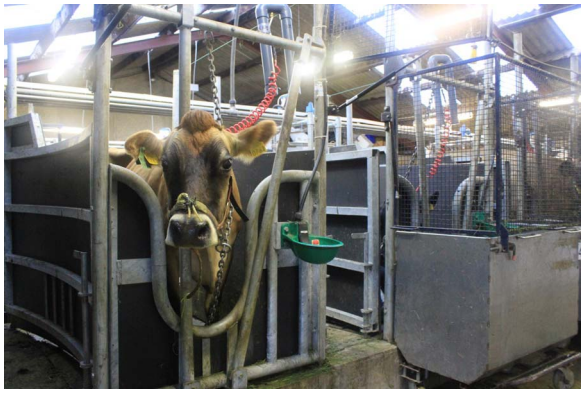

Fig. 1. Tie-stalls for metabolic measurements in dairy cows.