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Monitoring Indices of Cow Comfort in Free-Stall-Housed Dairy Herds*

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ABSTRACT

Indices of cow comfort are used widely by consultants in the dairy industry, with a general understanding that they are representative of lying behavior. This study examines the influence of stall base type (sand or a geotextile mattress filled with rubber crumbs) and time of measurement on 4 indices of comfort collected at hourly intervals in 12 herds, aligned by morning and afternoon milking. Stall base type significantly influenced all indices of comfort. For example, the least squares mean (SE) cow comfort index (proportion of cows touching a stall that are lying down) was 0.76 (0.015) in herds with mattresses compared with 0.86 (0.015) in herds with sand stalls. Significant hourly variation was also identified suggesting that timing of measurement is important. None of the indices of cow comfort derived from the high-yielding group pen was associated with the mean 24-h lying time of 10 sentinel cows whose time budgets were known in each herd. However, the cow comfort index was associated with the herd mean 24-h stall standing time, with the strongest relationships occurring 2 h before the morning and afternoon milking, when stall base type did not significantly influence the association. When measured at these times, we recommend use of the stall standing index (proportion of cows touching a stall that are standing), with values greater than 0.20 being associated with abnormally long herd mean stall standing times greater than 2 h/d.
(**Key words:** comfort index, stall use, lameness)

Abbreviation key: **CCI** = cow comfort index or quotient, **CCI/SSI$_{cow}$** = cow comfort index/stall standing index measured for the individual cows, **CCI/SSI$_{pen}$** = cow comfort index/stall standing index measured for the pen, **MAT** = geotextile-covered mattresses filled with rubber crumbs for free stalls, **SAND** = sand-bedded free stall, **SPI** = stall perching index, **SSI** = stall standing index, **SUI** = stall use index.

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INTRODUCTION

Indices of cow comfort, such as the cow comfort index (**CCI**) or cow comfort quotient, defined here as the proportion of cows touching a stall that are lying down, were first described almost a decade ago, and are used widely by dairy consultants to help them assess a dairy cow facility (Nelson, 1996). It is surprising, therefore, to realize that few studies have been published that investigate the use of CCI in commercial dairy herds. Despite widespread agreement that the CCI and equivalent indices are representative of good stall use by dairy cows, and therefore a reflection of daily lying behavior, no study has attempted to show just how well CCI or any other index of comfort is associated with daily lying behavior. Indeed, until recently, there were few guidelines on the appropriate timing of their measurement during the day.

Several studies have shown a diurnal pattern to feeding and lying activity in free-stall housing (Miller and Wood-Gush, 1991; Overton et al., 2002; DeVries and von Keyserlingk, 2005). One study tracked stall-use activity in a sand stall pen in a Californian dairy over an 8-d period (Overton et al., 2002, 2003). Peak lying activity was observed 1 h after return of the cows to the pen from the morning milking. This time coincided with the maximum CCI (Overton et al., 2003) and this was recommended as an optimal time to capture the best stall use in the herd. A target CCI of greater than 0.85 was suggested. In addition, the same researchers suggested the use of an alternative index known as the stall use index (**SUI**), which is defined as the proportion of cows that are in the pen, not feeding, and that are lying down in the stalls (Overton et al., 2003). The diurnal variation in this index appeared to be greater than in the CCI, and a target of greater than 0.75 was recommended when measured at a similar time (1 h after return from milking).

Variation in indices of comfort among herds has been documented infrequently. A study of 15 free-stall herds in Wisconsin determined an index of cow comfort equivalent to the reciprocal of the CCI, referred to here as the stall standing index (**SSI**, where SSI = 1 – CCI), which measured the proportion of cows touching a stall that were standing with all 4 feet on the stall platform or perching with the front 2 feet in the stall and the rear

2 feet in the alley (Cook, 2002). The SSI was collected 1 to 2 h before morning or afternoon milkings in both summer and winter and ranged from 6 to 35% between herds and seasons, suggesting a wide variation worthy of investigation.

The herd mean stall lying time and stall standing time derived from 10 sentinel cows in the high-yielding group pen in each of 12 herds obtained from a previous study (Cook et al., 2004), which evaluated individual cow time budgets, provided an opportunity to investigate variation in indices of cow comfort in herds with stall surfaces covered with geotextile mattresses filled with rubber crumbs (**MAT**), or stalls bedded with loose, deep sand (**SAND**). Specifically, there were 2 main aims for the current study. Firstly, to determine how different indices of comfort vary throughout the day in herds with different stall base types (MAT or SAND) and to identify periods of peak stall use. Secondly, the study aimed to determine how these indices are associated with the herd mean lying and standing times obtained from the 10 sentinel cows in each pen. The association was tested for 1 database with indices derived from the 10 sentinel cows, to test whether there was any association between index and behavior at a cow level, and for a second database in which the indices were derived from all of the cows in the high-yielding group pen in each herd, to test whether the association exists at the pen level. If there were such an association between indices and cow behavior, the timing of the optimal association would serve as a recommendation for the measurement of indices of comfort in other herds. The indices previously mentioned were calculated (CCI, SSI, SUI), and in addition, a third index was measured for the pen level data, referred to as the stall perching index (**SPI**), defined as the proportion of cows touching a stall that were standing with only the front 2 feet in the stall and the rear feet in the alley.

MATERIALS AND METHODS

Herd Selection and Data Collection

Twelve herds were used for the study. Selection criteria and background information for the herds have been documented in a previous publication on time budgets of individual cows that had been monitored for a 24-h period (Cook et al., 2004). The herds were between 150 and 450 cows with drive-through TMR feeding, a high-yielding group pen size of between 70 and 100 cows, and a stocking density not exceeding 125% (i.e., 125 cows per 100 stalls). Number of rows of stalls in the pen on each farm (2 or 3 row) and milking frequency (2 or 3 times/d) on each farm were equally distributed between 6 herds using sand-bedded stalls (SAND) and 6 herds using a rubber crumb-filled geotextile mattress (MAT). Four Sony miniDV video cameras (DCRTRV900; Sony Corp., New York, NY), mounted in the adjacent pen across the central feed alley and arranged to capture video of the entire high-yielding group pen in 4 overlapping zones, recorded 1 s of video every 30 s. A single 24-h period of activity was captured, during which there were no interruptions for breeding, injections, or other management tasks. Lights over the pen were left on during the night so that filming could continue for the full 24 h. Although not ideal, the herds studied were commercial dairy herds and a short period of all-day lighting has been used in other studies to facilitate recording without apparent major effects on cow behavior (Metz, 1985; Tucker et al., 2003; Cook et al., 2004). Filming was performed between April 2002 and May 2003 and avoiding the period typically associated with heat stress in Wisconsin (between July and October).

Cows selected for individual tracking were identified at least 1 h before the start of filming. Cows that were notably much smaller or larger than the pen average, cows with overgrown feet, and cows that were obviously severely lame (walking with an arched back, almost unable to bear weight on the affected limb; Cook, 2003) were not chosen. Severely lame cows represented only 3.2% of the population under study in the MAT herds and 0.7% of the population in SAND herds.

Calculation of Indices

Using a Panasonic AG-DV2000P MiniDV editing player and Panasonic CT-2089VYD high-definition color monitor (Matsushita Electric Corporation of America, Los Angeles, CA), the videotapes were analyzed hourly for each herd to create 2 databases. The first calculated the indices of comfort from the 10 sentinel cows only, and the second determined the indices from all of the cows in the pen, referred to subsequently using the subscript "cow" or "pen" after the index abbreviation to indicate the source of the data ($\mathbf{CCI_{cow}}$, $\mathbf{CCI_{pen}}$, $\mathbf{SSI_{cow}}$, and $\mathbf{SSI_{pen}}$). At each hour, the number of cows that were lying down in a stall, standing in a stall with all 4 feet, standing in a stall with the rear 2 feet in the alley (perching), and standing in the alley drinking and feeding were recorded. If it was not clear whether a particular cow was perching or standing with all 4 feet in the stall, a default value was used, which removed the observation from the analysis at that time point. Perching data were not available for the individual cow database. For each database and for each hour, 4 indices of cow comfort were calculated, namely CCI, SSI, SPI, and SUI. For the purpose of statistical analyses, CCI and SSI were the same, as one is the reciprocal of the other.