Impact of gestation and lactation stage on the dairy cow response following removal to unfamiliar housing and milking system

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Abstract

The objective of this study was to test the hypotheses that milk yield and behaviour at milking after relocation are impacted by gestation and lactation stages. Forty-one Holstein cows were relocated from the tie-stall barn with pipeline milking system into the barn with free-stall housing and herringbone milking parlour. Milk yield and order at the milking were recorded electronically. A significant decrease in daily milk yield was detected immediately after relocation (the first day) compared with the last day before treatment (23.76±7.21 kg vs 30.97±7.26 kg; P<0.001). However, the performance drop did not last long; after fourteen days milk production exceeded the mean original level (32.16±8.87 kg). No significant differences were found in the comparison of cows according to gestation stages. Cows in the second and first stages of lactation showed the highest declines in milk yield on the first day (36.77±6.34 kg and 33.76±7.44 kg vs 28.14±7.00 kg and 25.50±8.20 kg; P<0.05). Cows in the late lactation stage came into the parlour later than the other cows, equally during morning and evening milkings (P<0.05). Relationships between the lactation stage and milking orders were positive and significant (0.3730, 0.3946, 0.4822). We found that milk yield and behaviour at milking after relocation were influenced by the stage of lactation of the cows; however, the gestation stage had little long-term effect on the variables measured.

Introduction

The relocation process is generally regarded as stressful to cattle and includes both physical and psychological stimuli that can cause detrimental physiological and endocrine changes (Falkenberg et al., 2013). The removal of cows to an unknown barn has been implicated as one of the major stresses (Grandin, 1998). The situation is more complicated if the animals get used to the different housing and different way of milking. However, removing cows always depends on whether the cows go into a better or worse environment. The results of Popescu et al. (2014) show that the welfare quality of dairy cows is greatly influenced by the housing system and that the loose system is more advantageous when it comes to the feeding, housing and behaviour of the dairy cow.

In the study of Varner et al. (1983), Holstein cows were moved 100 m from a tie-stall barn into a free-stall facility with a double-six herringbone parlour. Milk yield decreased at first milking, but subsequent milk yields were similar to pre-relocation yields. Across groups, older cows and cows in late lactation tended to have the greatest decreases in milk yield. According to Sowerby and Polan (1978), the relocated cows declined only 0.99 kg of milk. Soch et al. (1997) found that the dairy cows’ milk yield decreased from 19.0 kg before relocation to 10.2 kg on the first day after moving from the tie-stall do free-stall housing. Brakel and Leis (1976) observed that the average milk yield of regrouped cows decreased by 3% on the first day following regrouping. Relocation of dairy cows could cause an increase in nervousness leading to worsen welfare (Boissy et al., 1998). Significant interference to cows’ well-being in our case was the manner of milking and parlour change (Bouissou et al., 2001). Especially when we consider that this was a change from pipeline milking system in tie-stall housing to milking in the milking parlour. Milking in unfamiliar environment may cause a negative response of the organism (Weiss et al., 2005). Parlour behaviour can be measured as a parlour entry order.

The aim of this study was to test the hypotheses that milk yield and behaviour at milking after relocation are impacted by the gestation and lactation stages.

Materials and methods

Forty-one Holstein cows were moved 120 m from the tie-stall barn into the barn with free-stall housing in the morning. Their average lactation and pregnancy stages were 202.56±134.65 and 52.02±75.22 days. The experimental period lasted of 25 days (during the months of November-December). The cows were fed a total mixed ration consisting of maize silage, alfalfa haylage, alfalfa hay, barley straw, brewer’s grain, sugar-beet pulp, and a concentrate mixture for high-yielding cows throughout the study. The feed ration was the same from the first week prior to removal through the fourth week following the move. Following the relocation, all cows had daily feed prepared in troughs. The feeding time was set at 9:00 h in both housing systems. The cows had free 24-h access to feeding except for milking time. In the barn with tie-stall housing, cows were milked by the pipeline milking system twice a day at 05:30 and 16:30 h. The last two individual milk yields were recorded during the evening and morning milkings (16:30 h, 5:30 h). The first milking after the removal was at the evening milking (16:30 h) and the second one on the next morning (5:30 h). Cows were milked in a double-five herringbone parlour at the same time as before removal.

The cows entered the parlour individually from the holding area with dimensions of 12.6
m x 6.0 m. Upon exit from the parlour, the cows walked through an alley that was 7.2 m x 0.85 m and passed over a scale. The cows had access to their free-stall pens immediately. Individual milk yield per day was calculated as the sum of evening and morning yields. The individual milk yields and order (from 1 to 10) were recorded electronically during the 24 milking sessions (at each milking). For each cow, entrance orders into milking parlour where she was milked and milk yield were recorded. These data were derived from the computerized identification of cows during an experimental period. During this period, the composition of group remained constant.

The data were analysed using a General Linear Model ANOVA by the statistical package STATISTIX, Version 9.0. Factors of day, stage of gestation (1, non gravid, n=24; 2, gravid from the 21st day to five months, n=10; 3, from five to nine months, n=7), and stage of lactation (1, from the 1st to 100th day, n=13; 2 - from 101st to 200th day, n=9; 3 - after 201st day, n=19) were evaluated. The dependent variables included all measures of milk yield and order at milking (from 1 to 10). The normality of data distribution was evaluated by the Wilk-Shapiro/Rankin Plot procedure. Significant differences between groups were tested by Comparisons of Mean Ranks. Values are expressed as means ± SD. The correlations between entrance order at milking and observed factors (gestation and lactation stages, side) and between entrance order at milking and milk yield in observed days were calculated using the Spearman rank correlation coefficient.

## Results and discussion

A significant decrease in daily milk yield was found immediately after relocation (the first day) compared with the last day before relocation (23.76±7.21 kg vs 30.97±7.26 kg; P<0.001). Immediately after the relocation, crowding occurs as cows explore new environments and are unable to navigate the pen. This leads to an increase in stocking density. It may increase feed competition, and subordinate cows may not be able to access feed. Another immediate effect of the removal is a reduction in the resting time, which can lead to physiological changes associated with stress. A study by von Keyserlingk et al. (2008) shows that regrouping can disrupt behaviour and production following this interference. Each regrouping exposes the cow to new individuals or new combinations of individuals. Dairy cows must establish their position in the hierarchy of the new group. We can assume that removal is likely a stressful event. We note that all observed cows were kept in the same tie-stall barn without daily exercise before relocation. Also, the significant milk yield reduction on the first day could be probably alleviated if cows were put into a loose housing pen or outside yard for some hours daily to acclimate them to a new social structure before relocation. Sowerby and Polan (1978) highlight the importance of adaptation; milk yield changed less in herds with previous experience of shifting. The findings we are presenting on the significant reduction of milk production after removal are in concordance with Soch et al., (1997). On the other hand, other scientists have identified a lower decline. Varner et al. (1983) found that the milk yield of relocated cows was decreased at first milking, but subsequent milk yields were similar to pre-relocation yields. The effects of herd relocation were negligible, and these authors indicate that dairy herds can be moved without an adverse effect on production traits. Brakel and Leis (1976), who measured the effect of an inter-group transfer, recorded a decrease in milk yield of 0.51 kg or 3% the day after cows were relocated, with no evidence of an effect on milk yield after Day 1. At the present work, performance drop did not last long and production increased as early as Day 3 and Day 4, but then this trend was reversed (Figure 1). Also, milk production exceeded the mean original level (32.16±8.87 kg) after 14 days. This indicates possible adaptation and improved welfare. The coping of cattle to different environmental processes certainly changes neuronal and endocrine functions (Huzzey et al., 2012; Kovács et al., 2013). The rapid return to the original milk yield was probably supported mostly by the strong adaptability of cows. There are several explanations for this important result of the quick return to the original milk yield values. We can attribute it to better conditions in the new barn and better well-being in free-stall housing. The freedom of movement in tie stalls is restricted in a way that causes unnecessary suffering. Cows in free-stall housing have a greater freedom for movement and exercise, and have more opportunity to improve production. In the present study, cows were not put into groups to adjust them to a new social structure before relocation. The reduction in milk production commencing on the 15th day is in line with prolonged lactation. Milk production is affected more significantly by a variety of factors, but the main factor is nutrition. However, we would not expect this result given that the total mixed ration was balanced and uniform throughout the whole trial. The negative effects are not based on forage quality. The methodical approach was accurate.

Apart from nutrition, the length of daylight can also come into play since cows exposed to a long photoperiod increased milk yield (Dahl et al., 2000). Many studies have shown that having different photoperiods for the different stages of a cow life cycle improves milk production. This is associated with an elevation of an endocrine mechanism for the galactopoietic effects. However, our experiment conducted during the months of November to December lasted only 25 days and could not reflect this. Also, we have not done any photoperiodical manipulations; we did not change the length or intensity of light in the barn.

No significant differences were found in the

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**Figure 1. Milk yield before and after relocation according to lactation stage.**
comparison of cows according to gestation stages. The greatest decline in the amount of milk the cow on the first day was recorded in dairy cows of 2nd and 1st gestation stages (25.50±6.28 kg and 24.01±8.05 kg vs 33.92±8.51 kg and 31.67±6.53 kg). Daily milk yields differed only in the first gestation stage (days 1:13,14; P<0.05). Open cows showed a slightly less decreased milk yield immediately after relocation compared to gravid cows (7.66 kg vs 8.42 kg). Gravid cows are much more likely to be sensitive. However, the impact of gestation on milk yield depends on the lactation stage, according to Olori et al. (1997). The effect is higher in mid-lactation than in late lactation. Significant effects of gestation on milk yield is usually observed from the fifth month of gestation onwards (Olori et al., 1997; Roche, 2003; Brotherstone et al., 2004). We must not forget the effects of the photoperiod during the third trimesters of pregnancy on hormone prolactin, although, that would most likely affect future milk production. Gestation also has an impact on a cow's production, as it causes mammary gland regression and competition for nutrients from the developing foetus, resulting in a reduction in yield. The effect of gestation varies with gestation stage (Olori et al., 1997; Sabbioni et al., 2012); the influence is small at the beginning of gestation and becomes greater at later stages of gestation. Cows that conceive in the first three months in milk have lactation curves similar in shape and height to the lactation curves of non-pregnant cows (Brotherstone et al., 2004). This may have caused a slight non-significant difference between milk yield of the first and second gestation groups. The slope of the milk yield curve decreases in gravid cows much more rapidly only after the 200th day of lactation. Cows becoming gravid in mid-lactation have a similar shape of the lactation curve as the open cows, but the yield of these cows is consistently higher than the yield of the open cows. This means that the shape of the lactation curve depends on the stage of lactation when pregnancy occurs. The highest declines in milk yield on the first day was observed in cows in the second and first stages of lactation (36.77±6.34 kg and 33.76±7.44 kg vs 28.14±7.00 kg and 25.50±8.20 kg; P<0.05). There were no significant differences in the first and second lactation stages during the experiment; differences were calculated in the third lactation stage only (days 14:9,10, P<0.05; 14:12, P<0.05). That confirmed Varner et al. (1983) findings that cows in late lactation tended to have the greatest decreases in milk yield after relocation.

The results of our study further agree with the reported decreased milk production found by Soch et al. (1997). However, some other authors showed an inexpressive influence of gestation (Brakel and Leis, 1976; Sowerby and Polan, 1978). It should be noted though that our treatment was much more uncomfortable for the cows; they had to cope not only with a change in housing but also in milking. When we calculated the percentage of drop in milk yield after removal individually, we found that some cows in the lactation stage groups (one cow in each group, 7.7 %, 11.1 %, and 5.3 %) increased milk yield after removal, while the others tended to maintain balanced milk production. However, Weiss et al. (2004) found a decreased milk yield of 69 % relative to the previous parlour yield during the first milking in an automated milking system. The changes in milk yield could be due to multiple reasons. Since the ability of an animal to change its behaviour to cope with the environment is modified by previous experience, adaptation to shifting is possible. Although physical contact was not quantified, decreases in physical abuse of new group mates might account for later increases in milk production. Whenever cows are regrouped, the group’s social structure becomes disrupted and a temporary increase in aggression level is typically observed until the new dominance order is established. Social order is closely related to the order of milking. However, our experimental cows were not able to not create a social hierarchy in the previous housing, and the group’s social structure was a novelty for them. That is why it was important to examine their behaviour when they were entering the parlour.

Although entry order may be affected by social dominance (Gadbury, 1975; Albright and Arave, 1997), it may also be determined by stress from entering the milking parlour. Negative past experiences may pose a problem, as demonstrated by some cows that entered the milking parlour reluctantly. However, little is known about the stability of the milking parlour entry order in dairy cows and how it differs depending on the stages of gestation or lactation. Differences found in the order at milking according to gestation stage groups were negligible. No significant differences in the milking order of all cows were recorded between morning and evening milkings. The highest order at milking was showed in cows after the 201th day of their lactation. The highest ranking occurred in cows in the third stage of lactation, including in the morning and evening milkings (6.40±2.94; 6.56±2.84). Differences among lactation stage groups were significant (P<0.05) (Table 1). This could be related to the age and body weight, although not to previous experience. Hafez and Bouissou (1975) reported that entrance to the milking parlour should be considered as a voluntary movement, different from forced movements as in manipulations. Clark et al. (1977) and Grasso et al. (2007) concluded that management practices that disturb the entrance order should be removed to reduce stress.

In the present work, cows in their first and second lactation stages entered the parlour earlier than cows in their third stage, equally during morning and evening milkings. Cows in their late lactation stage entered the parlour last. Rathore (1982) in dairy cattle and

Table 1. Effect of lactation stage on order of cows at milking.

| Order | Stage of lactation | Significance |
|-------|--------------------|--------------|
| Morning | N                  | 1            | 2           | 3           | 4          |
| 143   | 5.58±2.66          | 99           | 5.68±2.86   | 209         | 6.40±2.94  | 0.047*, 3:1.2* |
| Evening | 143               | 5.64±2.88    | 99          | 5.59±2.78   | 209         | 6.56±2.84  | 0.010*, 3:1.2* |

*P<0.05.

Table 2. Correlations between milking behaviours and observed parameters.

| Variable | Age | Body weight | Lactation stage | Gestation stage |
|----------|-----|-------------|-----------------|-----------------|
| Morning | -0.3728*| -0.2266   | 0.3730*         | 0.1556         |
| Evening | -0.1586 | -0.2326  | 0.3946*         | 0.1876         |
| Total   | -0.3928*| -0.3267*  | 0.4622**        | 0.2505         |

*P<0.05; **P<0.01.
Margetanova et al. (2003) in goats proved that those animals entering first the milking parlour had higher milk yields than those entering last. Other studies also showed that primiparous cows, kept in the group of multiparous cows, enter last into the milking parlour (Mincinski et al., 2010). However, the entrance order for milking was mostly influenced by the stage of lactation and at the least by the daily milk production according to Varlyakov et al. (2011). Highly productive cows are never the majority among those that are first or last to enter for milking. Relationships between the milking order during morning and evening and age or body weight were negative and often close (P<0.05). Lactation stage correlated positively and significantly with the order in the morning, evening and total milkings (0.3730*, 0.3946*, 0.4822**) (Table 2). The adaptation to cows, enter last into the milking parlour those animals entering first the milking parlour was unexpectedly fast, especially since this was a change from the pipeline milking system in tie-stall housing to milking in the parlour. One of the reasons highlighted by Grasso et al. (2007) could be a good relationship between the milkers and the cows. According to Grandin (1998), cattle with excitable temperaments must be introduced gradually to new experiences. It is important that their first experiences with something new are good. It is known that dairy cows with a sense of fear of humans can reduce milk production and change their behaviour at milking (Albright and Arave, 1997; Rushen et al., 1999; Munksgaard et al., 2001) and a reduction in milk yield has been reported for cows milked by different milkers. Moreover, fear of humans can be aggravated by the unusual noise of the milking parlour. A variety of past environmental factors and previous experiences have a significant effect on emotional reactivity (Boissy et al., 1998). If animals are capable of social learning, their level of fear could be reduced if they were handled and trained by gentle operators. However, experimental milkings were always done by new, unfamiliar barn staff. In the present study, cows were not trained; therefore, relocation could provoke a fear of novelty and people. There were noticeable effects on cows associated with removing to the new facility. The reactions towards the changeover to a housing system varied widely within cows. However, changes after the observation of the milking session indicate that cows are able to adapt quickly to environmental change.

An additional study is needed in group management to determine the most efficient number of cows in groups and the optimum production for each. Factors such as herd size, feeding, and milking system need to be considered in defining the optimum system. It is necessary to improve the practical procedures that may disturb cows entering the milking parlour.

Conclusions

The results of this study suggest that relocation from the tie-stall barn with pipeline milking system into the barn with free-stall housing and milking parlour caused cows to decline milk production. These changes do not have a long-lasting impact on the following daily milk production. After fourteen days the milk production exceeded the mean original level. We found that the milk yield and behaviour at milking after relocation were influenced by the stage of lactation of cows, but the gestation stage had a little long-term effect on the variables measured. More research is needed, especially in examining the methods of reducing stress associated with this type of relocation.

The specific type of cow relocation (from the tie-stall to free-stall housing) caused cows to decline milk production. However these changes have not a long-lasting impact on the following daily milk production. After fourteen days the milk production exceeded the original mean level. We found that the milk yield and behaviour at milking after relocation were influenced by the stage of lactation of cows, but the gestation stage had a little long-term effect on the variables measured.

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