

# Cubicle Refusal and Rearing Accommodation as Possible Mastitis Risk Factors in Cubicle-Housed Dairy Heifers

By H. P. Kjæstad and E. Simensen

The Norwegian School of Veterinary Science, Department of Large Animal Clinical Sciences, Oslo, Norway.

**Kjæstad HP, Simensen E: Cubicle refusal and rearing accommodation as possible mastitis risk factors in cubicle-housed dairy heifers. Acta vet. scand. 2001, 42, 123-130.** – Fifty-nine of the 65 dairy farms with cubicle sheds in the Norwegian county of Oppland in 1990 were included in a study of rearing accommodation, cubicle refusal and mastitis incidence. The farmers recorded the favoured resting location of the individual cows and heifers throughout the final week of pregnancy as well as during calving. The observations were matched with individual records of mastitis cases during the first 30 days after calving. Mastitis incidence in the heifers was analysed by logistic regression using rearing accommodation and cubicle refusal as independent variables, controlling for herd as a clustering factor. Cubicle refusal was found in 29% of the heifers, but in only 3% of older cows. The results of the analysis indicated a tendency for cubicle refusal to be associated with an increased mastitis incidence among the heifers (OR=2.2, c.i.<sub>95%OR</sub>=0.9-5.4, P=0.08). Cubicle refusal accounted for 21% (0-32%) of the mastitis cases in the study population (PAF=0.21).

*dairy cows; cubicle housing; cubicle refusal; mastitis.*

## Introduction

Cubicle housing systems for dairy cows have a number of advantages over a tie barn, such as better reproduction and health among the cows (Ekesbo 1966, Bakken *et al.* 1988, Østerås 1990, Valde *et al.* 1997), good opportunities for them to exhibit different types of behaviour, and improved working conditions for the herdsman. Increasing attention to these factors has contributed to the building of many cubicle houses also in countries with small dairy farms, such as Norway. In a study of 186 out of 273 dairy farms with cubicle housing in Norway in 1990, the median herd size was found to be 18 cows (range 7-118) (Kjæstad & Myren 2001). The cows' use of the cubicles obviously depends on an initiative by the individual animal, and it may be influenced by factors such as cubicle-cow ratio (Kaiser 1974, Friend *et al.*

1977, Wierenga & Hopster 1990), cubicle design (McFarland & Gamroth 1994, O'Connell *et al.* 1991), and the softness of the cubicle surface (*e.g.* Jensen *et al.* 1988, O'Connell *et al.* 1993). Results from a previous study of Norwegian dairy herds showed that 6% of the cows in cubicle sheds refused to use the cubicles for resting, a behaviour hereafter referred to as cubicle refusal. However, the refusal percentage varied considerably between herds, and in some herds, more than 50% of the animals refused to use the cubicles (Kjæstad & Myren 2001). Cubicle refusal leads to soiling of the cow's udder and belly with urine and faeces, and contamination of the udder with a number of potentially pathogenic faecal bacteria, for instance *Escherichia coli*. In addition to increasing the load of pathogenic bacteria on the udder, lying

on the dirty slatted floor makes the udder wet, and evaporation, as well as contact with the cool floor and draft between the slats, leads to local chilling, which may result in decreased local resistance (Dyrendal & Ewbank 1968). It is known that the incidence of *E. coli*-associated mastitis is higher in wet and dirty dairy barns than in dry and clean ones (Bartlett *et al.* 1992). We therefore suggest that animals which choose to lie in the alley are at a higher risk of developing mastitis than cows which choose to rest in cubicles. It is also probable that persistent cubicle refusal leads to premature culling of an animal because it increases the labour associated with cleaning the udders before milking.

An association has previously been found between rearing heifers in slatted floor pens and the occurrence of cubicle refusal in the dairy herd (Kjæstad & Myren 2001), but the rearing environment may of course influence udder health by other factors than predisposing heifers towards cubicle refusal. Studies of tie-stall herds suggest that rearing heifers in group pens is associated with an increased mastitis incidence (Pettersen 1981, Østerås *et al.* 1994)

The present work was undertaken to study the incidence of cubicle refusal by heifers and cows, and to study the relationship between rearing accommodation, cubicle refusal and the incidence of clinical mastitis.

### Materials and methods

All farms in Oppland county with cubicle sheds in 1990 were identified with the help of regional agricultural authorities, other farmers, and practising veterinarians. The farmers were contacted and asked to participate in the study.

Sixty-five farms with cubicle sheds were identified and the farmers contacted. Five herds were entirely excluded from the study, three because the farmers did not want to participate in

the study, and the other 2 because of lack of data recording and stocking twice as many cows as the number of available cubicles, respectively. All the herds included were visited before the calving season started, the cow-houses inspected, and notes made of whether the heifer rearing facilities were slatted floor pens or other types of accommodation. During the visit, the farmers were instructed to record data for individual cases on specially designed forms. The information requested was:

- Calving date and calving number
- favoured resting site of the cow or heifer during the week before calving (cubicle, alley, halfway inside cubicle, combinations, or unknown)
- site of calving (cubicle, alley, other, or unknown)
- rearing accommodation of heifer (slatted pen or other accommodation - also confirmed by farm visit).

One form containing the requested information was to be completed for each calving that took place. All farmers were contacted by telephone one to two months after the calving season had started. The data were collected by the end of the calving season and reviewed in collaboration with the farmer.

The cases of mastitis in the herds were diagnosed and recorded by the local practising veterinarians. The general definition of mastitis used was “clinical mastitis with signs of chronic or acute inflammation” (The Royal Ministry of Agriculture 1988). The individual disease records or “health cards” were kept on the farm, and the data regularly transferred to a central computer data base according to the practice of the Norwegian Herd Recording System (NHRS), an extensive recording system for health and production data (Solbu 1983). For each animal, the corresponding data on the

Table 1. Cubicle use by cows and heifers in cubicle sheds throughout the final week of pregnancy.

Cubicle use throughout the final week of pregnancy	Age group		
	Heifers expecting first calf (n <sub>1</sub> =368)	Cows expecting second calf (n <sub>2</sub> =261)	Older cows (n <sub>3</sub> =415)
Consistent or occasional cubicle refusal, total or with hind quarters	107 (29%)	8 (3%)	12 (3%)
Consistent cubicle use	261 (71%)	253 (97%)	403 (97%)

OR of cubicle refusal in heifers compared to cows: 13.29 (c.i.<sub>95%</sub>OR =7.89-22.61, P<0.01)

occurrence of clinical mastitis were matched with the data on cubicle use recorded by the farmers.

Data on a total of 1125 calvings in the 60 herds were collected. Median herd size was 18 cow-years (range 11-109), and the median number of forms returned from each herd was 17 (range 7-54). Most of the calvings took place from *primo* July throughout October, 1990.

Of the 1125 animals in the study, 36% were first-calving heifers, 25% were cows giving birth to their second calf, and the remainder were cows at their third calving or later. About 10% calved while out on pasture, while 78% of the remaining calvings took place in the cubicle-equipped section. Thirteen percent calved in a calving pen, the remaining animals were tethered at the time of calving.

The rearing environment of 387 of the 404 heifers was known. Of these, 86% had been reared in slatted floor pens, while the remaining 14% had been reared in various other facilities, mainly involving individual tethering.

### Statistics

The incidence of mastitis during the first 30 days after calving (abbreviated MAST) was analysed by logistic regression for distinguishable data with herd as a random effects variable (*Statistics and Epidemiology Research Corporation* 1991). One herd was excluded from the

analyses of mastitis incidence because it was not a member of the NHRS, reducing the population at risk to 1116 animals in 59 herds.

Only the first calving heifers were subjected to analysis because of low total occurrence of cubicle refusal in the older cows as well as the fact that variation in age made that group very heterogeneous. The other variables used in the analyses were:

- Cubicle refusal throughout the final week of pregnancy (CUBREF), “1” denoting cubicle refusal, “0” denoting cubicle use
- rearing accommodation (SLATS), “1” denoting slatted pen, “0” other accommodation.

Rearing in slatted floor pens has previously been linked with cubicle refusal (*Kjæstad & Myren* 2001). Therefore, it would not have been appropriate to include both SLATS and CUBREF in the same model. Instead the 2 independent variables were analysed one at a time using the models:

$$\text{MAST} = a + b\text{SLATS}$$

$$\text{MAST} = a + b\text{CUBREF}$$

a being the regression constant (general mean), and b the regression coefficient of the independent variable. Each of the models was also tested with the addition of an interaction term

Table 2. Results of logistic regression analysis of cubicle refusal and rearing accommodation as risk factors for mastitis during the first 30 days after calving.

(The total number of heifers in the population at risk was 399. Analysis not possible for 58 records due to missing values for at least one variable)

Models:

$$\text{MAST} = a_1 + b_1 \text{SLATS}; \text{MAST} = a_2 + b_2 \text{CUBREF}$$

$a_n$  being the regression constant (general mean), and  $b_n$  the regression coefficient of the independent variable.

Name of term	Explanation	a	b	SE	P	OR	c.i. <sub>95%</sub> (OR)
SLATS	Rearing accommodation of heifer (1=group pen, 0=other)	-2.72	-0.03	0.68	0.97	0.97	0.26-3.69
CUBREF	Cubicle refusal throughout the final week of pregnancy (1=yes, 0=no)	-3.01	0.80	0.46	0.08	2.23	0.92-5.44

consisting of the product of the independent variables (SLATS × CUBREF).

The population attributable fraction (PAF) for the risk factors was determined using the calculated OR values in the following formula, described by *Bruzzi et al.* (1985):

$$\text{PAF} = 1 - \sum(p(D_i|D+)/OR_i)$$

## Results

Data on cubicle refusal and calving number were reported for 1045 cows and heifers. Cubicle refusal throughout the final week of pregnancy, either intermittent or constant, was shown by 12%. This pattern of behaviour was more frequently seen in heifers than in first lactation cows or older cows (Table 1).

The total incidence rate of mastitis during the first 30 days after calving was 8.7%. Mastitis was reported in 6.8% of the first-calf heifers and in 9.6% of the cows (Cows' OR=1.5, c.i.<sub>95%</sub>OR=0.9-2.4, p=0.08). The mean number of days from calving until an eventual mastitis diagnosis was 8 in both heifers and cows. The diagnosis was made on the calving date in 2 heifers and in 10 cows.

The rearing environment variable (SLATS) did not contribute significantly as a single independent variable in analysis of mastitis incidence

(OR=1.0, c.i.<sub>95%</sub>OR= 0.3-3.7, p=0.97) (Table 2). However, the cubicle refusal variable (CUBREF) indicated a positive association, approaching statistical significance (OR=2.2, c.i.<sub>95%</sub>OR=0.9-5.4, p=0.08) (Table 2). Adding the interaction term to the analyses resulted in non-convergence and did not provide further information.

The PAF value for the contribution of CUBREF to MAST was found to be 0.21 (-0.03 to 0.32 when employing respectively the lower and upper 95% confidence limits of the OR).

A strong association was detected between rearing in slatted floor pens (n=328) and the occurrence of cubicle refusal (n=106) by the heifers (OR=5.1, c.i.<sub>95%</sub>OR=1.8-20.2, p<0.01).

## Discussion

Instead of sampling farms throughout the country, we included all cubicle-housed herds in a certain geographical area. Oppland county was chosen because of the area's accessibility in relation to the Norwegian School of Veterinary Science, and known to have many dairy farms with cubicle sheds of various sizes located in geographically diverse environments.

To ensure a fairly large number of observations, the farmers were employed as observers. They

had no previous training for this task, and in order to achieve a certain degree of standardization, the behaviour-observation process was made as simple as possible, demanding little need for interpretation or special knowledge of behaviour. Each farmer was also given instructions verbally of how to record the requested data.

Systematic associations between an actual observation and the probability of that value being missing in the data set, such as consistent under-reporting of e.g. cubicle refusal, were considered to be unlikely. The risk of data bias due to missing values was therefore regarded as acceptably low.

The data set contained observations from many different herds. One must assume that there was a stronger degree of dependence between the observations within one herd than between observations from different herds. On this background the total set can be seen as consisting of a number of data subsets or clusters. Logistic-binomial regression with random effects is a procedure that allows for the possibility of taking clustering factors into account (*Statistics and Epidemiology Research Corporation* 1991) and it was therefore chosen for statistical analysis of the data.

Cubicle refusal was higher than previously found by *Kjæstad & Myren* (2001). Using a similar classification method for cubicle use, they reported that 6% of the cows showed cubicle refusal. However, in the present study, cubicle use recording was by design associated with late pregnancy, while in the cited study there was no association between recording cubicle refusal and pregnancy status.

The prevalence of cubicle refusal was higher in the heifers than in the cows. This is as expected because most of the heifers had been reared in facilities lacking cubicles and, in accordance with the traditional practice, transferred to the cubicle yard few weeks before expected calv-

ing. The heifers were therefore in a phase of learning how to use the cubicles when their behaviour was recorded. Some of the difference in cubicle refusal between heifers and older cows may have been due to culling of animals showing the undesirable behaviour because their udders become dirty, resulting in more laborious preparation of the cow before milking.

The practice of grazing has been shown to lower the risk of mastitis in heifers. *Waage et al.* (1998) found that the incidence is reduced during the grazing months in herds that are kept on pasture compared to herds practicing zero grazing. An association between grazing/keeping heifers outdoors and decreased mastitis risk is also reported by *Bendixen et al.* (1986) and *Schukken et al.* (1988). Some of the heifers in the present study had evidently been out on pasture for a shorter or longer time, as pasture was indeed the reported calving location in a few cases. However, because we did not know the duration of the pasture period of these heifers and, on the other hand, were unable to determine whether the remaining heifers also had been grazed, we could not include pasture as a reliable variable in our analysis. It is therefore difficult to speculate whether this may have influenced the results. Nevertheless, it is likely that grazing was practiced for either all or none of the heifers in the herd, so that some of the eventual variation due to this practice will have been addressed by including the herd clustering factor in the analyses.

The result of the analysis using cubicle refusal instead of rearing accommodation indicates that the former variable is the most important as a possible risk factor. Interaction between the independent variables did not seem to be important, as the analyses did not improve after adding the interaction term.

Concerning cubicle refusal *per se*, we know that a number of the bacteria species normally present in faeces are potential mastitis patho-

gens, e.g. faecal streptococci and *Escherichia coli* (Bramley & Dodd 1984). The pathogenic bacteria can enter the udder when the cow is resting on a very contaminated surface like the alley of a cubicle house. Moreover, the moisture and draft from the slatted floor of a cubicle house cause chilling of the udder of cows refusing to rest in cubicles. Local chilling of the udder decreases resistance to infection, and is sufficient by itself to cause acute mastitis (Dyrendal & Ewbank 1968).

The PAF value for cubicle refusal that was found in the present study is relatively large (0.21). We consider this to be an important result, because it means that perfect control of cubicle refusal may lead to a significant reduction of mastitis in first calved heifers during the first month *post partum*.

In the present study, rearing accommodation did not contribute significantly to the mastitis incidence analysis when being the sole independent variable. The finding was unexpected, because we did find a tendency for cubicle refusal to be significant, and cubicle refusal was also significantly associated with rearing in slatted floor accommodation. The absence of a detectable contribution by rearing accommodation alone in the present material may be due to the uneven distribution between the 2 rearing environment categories, i.e. the number of heifers that were reared in other accommodation than slatted floor pens was relatively small. Previously, other studies have indicated that heifer rearing accommodation is indeed a mastitis risk factor. A study by Pettersen (1981) reports that heifers reared in group pens have a considerably higher risk of being diagnosed with mastitis at first milking than those reared in tie stalls. This is supported by the results of Østerås *et al.* (1994), who studied the differences in housing and management between herds with especially high or low mastitis-associated costs. Among other factors, they con-

clude that herds in which heifers were kept in group pens have a higher tendency to be found in the high cost group compared to the herds in which other heifer accommodation is employed. Neither of the cited studies discloses the actual flooring type in the heifer pens, but it is probably safe to assume that the majority had slatted floors, as this is the most common flooring type found in such accommodation throughout this country. However, floor type is certainly not the only plausible risk factor common to group pens, and other factors such as sucking among heifers were indeed discussed in the cited studies.

The discrepancy between the cited studies and the present one in respect to the effect of accommodation may be due to differences in material sizes and group sizes. In our study, the group reared in other accommodation than pens was very small. The material studied by Østerås *et al.* (1994) was considerably larger than that of the present study. Pettersen's (1981) material size is comparable to ours, but it has a higher mastitis incidence, making it more likely to detect effects of rearing environment. It also addresses mastitis at first milking, indicating that the disease may have been present before calving. In the present study, mastitis before calving was not monitored, and in the few instances when mastitis was found at first milking, the case was included in the analysis as another eligible case. Therefore, the aetiology of the mastitis cases may be different.

We conclude from the present study that cubicle refusal around calving is primarily a problem of heifers, and that cubicle refusal behaviour constitutes a mastitis risk factor for dairy heifers.

#### Acknowledgement

The Norwegian Research Council provided the funding for this study. The authors also want to thank Dr. Arne Flåøyen and Dr. Olav Østerås for their assistance in preparing the manuscript.

## References

- Bakken G, Røn I, Østerås O*: Clinical disease in dairy cows in relation to housing systems. In: Proceedings of the 6th International Congress on Animal Hygiene, Skara 1988. Swedish University of Agricultural Sciences, Skara. 1988, pp 18-22.
- Bartlett PC, Miller GY, Lance SE, Heider LE*: Managerial determinants of intramammary coliform and environmental streptococci infections in Ohio dairy herds. *J. Dairy Sci.* 1992, *75*, 1241-1252.
- Bendixen PH, Vilson B, Ekesbo I, Åstrand DB*: Disease frequencies of tied zero-grazing dairy cows and of dairy cows on pasture during summer and tied during winter. *Prev. Vet. Med.* 1986, *4*, 291-306.
- Bramley AJ, Dodd FH*: Reviews of the progress of Dairy Science: Mastitis control - progress and prospects. *J. Dairy Res.* 1984, *51*, 481-512.
- Bruzzi P, Green SB, Byar DP, Brinton LA, Schairer C*: Estimating the population attributable risk for multiple risk factors using case-control data. *Am. J. Epidemiol.* 1985, *122*, 904-914.
- Dyrendal I, Ewbank R*: An experimental demonstration of the effect of surface cooling upon the health of the bovine mammary gland. *Vet. Rec.* 1968, *84*, 685-686.
- Ekesbo I*: Disease incidence in tied and loose housed dairy cattle. *Acta Vet. Scand.* 1966, *15*, *Supplement*, 6-74.
- Friend TH, Polan CE, McGilliard ML*: Free stall and feed bunk requirements relative to behavior, production and individual feed intake in dairy cows. *J. Dairy Sci.* 1977, *60*, 108-116.
- Jensen P, Recen B, Ekesbo I*: Preference of loose-housed dairy cows for two different cubicle floor coverings. *Swed. J. Agric. Res.* 1988, *18*, 141-146.
- Kaiser R*: Untersuchungen zum Verhalten von Milchkühen im Boxenlaufstall bei unterschiedlichem Tier-Liegeplatz-Verhältnis und ständig freiem Zugang zur Krippe. *Die Tierzucht* 1974, *28*, 187-189.
- Kjæstad HP, Myren HJ*: Cubicle refusal in Norwegian dairy herds. *Acta Vet. Scand.* 2001, *42*, 181-187.
- McFarland DF, Gamroth MJ*: Freestall designs with cow comfort in mind. In: Bucklin R (ed.): Proceedings of the Third International Dairy Housing Conference, Orlando, Florida 1994. American Society of Agricultural Engineers, St. Joseph 1994, pp 145-158.
- O'Connell JM, Meaney WJ, Giller PS*: An evaluation of four cubicle designs using cattle behaviour criteria. *Ir. Vet. J.* 1991, *44*, 8-13.
- O'Connell JM, Giller PS, Meaney WJ*: Weanling training and cubicle usage as heifers. *Appl. Anim. Behav. Sci.* 1993, *37*, 185-195.
- Pettersen, K-E*: Mastitt hos kviger før kalving (Mastitis in heifers before calving). In: *Jurhelse hos geit og ku* (Udder health in goats and cows). Thesis, Norwegian College of Veterinary Medicine, Oslo 1981.
- Schukken YH, Erb HN, Sears PM, Smith RD*: Ecologic study of the risk factors for environmental mastitis. *Am. J. Vet. Res.* 1988, *49*, 766-769.
- Solbu H*: Disease recording in Norwegian Dairy cattle. *Zeitschr. Tierzücht. Züchtungsbiol.* 1983, *100*, 139-157.
- Statistics and Epidemiology Research Corporation (SERC)*: Epidemiological graphics, estimation, and testing package (EGRET), version 0.26.6. Seattle 1990.
- The Royal Ministry of Agriculture*: Brukerorientering for rapportering av dyresjukdommer (User's manual for reporting of animal diseases). Circular M-0577, Oslo 1988.
- Valde JP, Hird DW, Thurmond MC, Østerås O*: Comparison of ketosis, clinical mastitis, somatic cell count, and reproductive performance between free stall and tie stall barns in Norwegian dairy herds with automatic feeding. *Acta Vet. Scand.* 1997, *38*, 181-192.
- Wierenga HK, Hopster H*: The significance of cubicles for the behaviour of dairy cows. *Appl. Anim. Behav. Sci.* 1990, *26*, 309-337.
- Østerås O*: Sykdomsforekomst hos kyr i båsfjøs og løsdriftsfjøs (Disease incidence in cows in stanchion sheds and loose housing). In: Proceedings of Husdyrforsøksmøtet, Ås 1990. Statens Fag tjeneste for Landbruket, Ås. 1990, pp. 232-237.
- Østerås O, Varhaug J, Hansen BG, Sandvik L*: Miljøforskjeller i besetninger med meget god og meget dårlig jurhelse i Rogalandsmeieriet (Environmental differences in herds with very good and very poor udder health). Rogalandsmeieriet, Sola 1994.
- Waage S, Sviland S, Ødegaard SA*: Identification of risk factors for clinical mastitis in dairy heifers. *J. Dairy Sci.* 1998, *81*, 1275-1284.

**Sammendrag**

*Gangligging og kvigebinge som mulige risikofaktorer for mastitt hos kviger i liggebåsfjøs.*

Formålet med studien var å undersøke forekomsten av gangligging hos kviger og kyr i løpet av den siste uken før kalving, samt å analysere eventuelle sammenhenger mellom oppstalling på spaltegolvbsbinge, gangligging og klinisk mastitt hos kvigene i de første 30 dager etter kalving. Femtini av de i alt 65 besetningene med løsdrift i Oppland fylke i 1990 ble inkludert i studien. Det ble utformet et spørreskjema hvor bonden noterte kyrnes/kvigenes foretrukne liggeplass den siste uka før kalving. Opplysninger om

sjukdomsbehandlinger ble hentet fra helsekortordningens data i Kukontrollens database. Mastittforekomst hos kvigene i løpet av 30 dager etter kalving ble analysert ved logistisk regresjon med besetning som tilfeldig effekt-variabel, og type av oppstalling for kvigene før overføring til kuflokken og gangligging som uavhengige variable. Gangligging forekom hos 29% av kvigene, men bare 3% av kyrne, og det ble påvist en tendens til at gangligging hos kvigene hadde sammenheng med økt mastittfrekvens (c.i.<sub>95%OR</sub>=0.9-5.4, p=0.08). Tjueen prosent (0-32%) av mastittene i denne populasjonen kunne tilskrives gangligging som årsaksfaktor (PAF=0.21).

*(Received August 3, 2000; accepted October 8, 2000).*

Reprints may be obtained from: H. P. Kjæstad, Department of Large Animal Clinical Sciences, P.O. Box 8146 dep., 0033 Oslo, Norway. E-mail: hans.p.kjaestad@veths.no, tel. +47 22 96 49 56, fax: +47 22 96 47 61.