Management Factors Influencing Calf Mortality and Blood Immunoglobulin Levels in Michigan Dairy Herds
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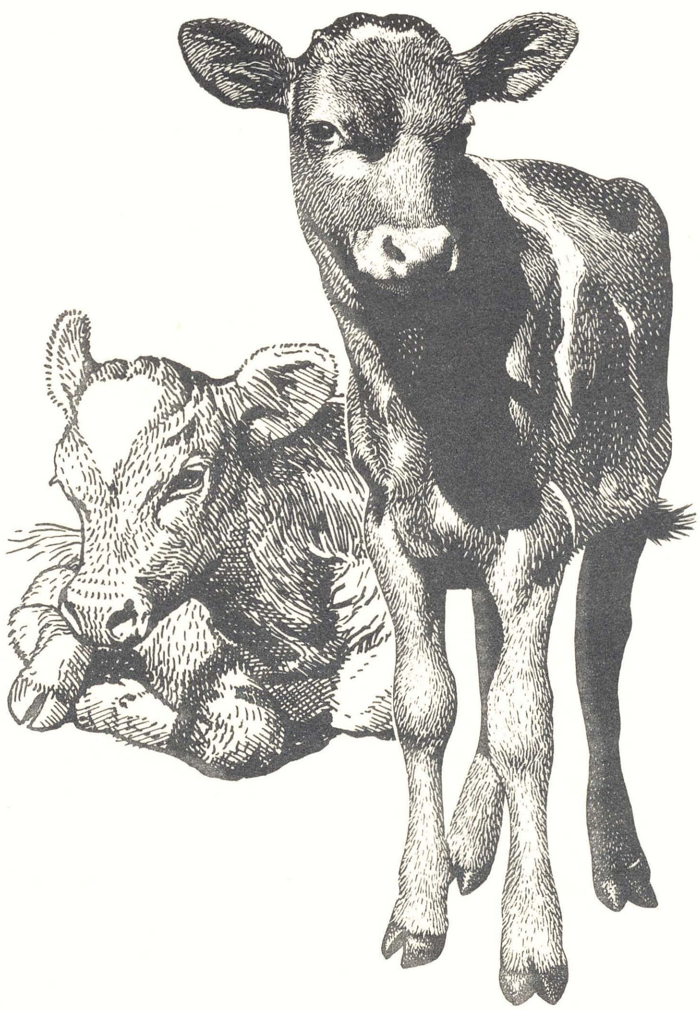


SUMMARY

Immunoglobulin (antibody) levels in blood of 2-day-old calves were measured in calves from 30 Michigan dairy herds. Calves depend on colostrum consumption for these immunoglobulins. Factors affecting these blood immunoglobulin levels and the mortality rate in these herds were investigated during a 5-month study.

The evaluation of 48 hr blood immunoglobulin levels from 456 calves indicated that herds with low mortality (<10%) did not have higher levels than those with high mortality (>15%). However, there were significantly lower immunoglobulin levels in calves that died than in calves that lived. More calves with low immune levels died in herds with high mortality than in herds with low mortality. This suggests a relationship between immune levels and "environment."

Results from the field study and controlled experiments in the MSU herd indicate that the amount of colostrum fed within the first 36 hr of life is directly related to blood immunoglobulin level. Time to the first colostrum feeding influenced blood immunoglobulin level at 24 hr but did not affect the level by 48 hr, apparently because calves were given more colostrum after 12 - 24 hr. Calves with lower levels at 12 or 24 hr benefitted more from subsequent colostrum consumption than did calves with higher levels at 12 or 24 hr. The immunoglobulin level at 24 hr was positively related to amount of colostrum consumed to 18 hr.

The method Michigan dairymen employed to get colostrum to newborn calves during the first 36 hr affected average immunoglobulin levels at 48 hr. Herds in which calves were allowed to remain with the dam for 24 - 48 hr after birth had the highest average immunoglobulin levels. Herds which depended on handfeeding of colostrum and in which the calf was removed before 12 hr had calves with immunoglobulin levels close to those in which the calf and cow were left together. However, herds in which calves remained with the dam for slightly more than 12 hr to obtain their first colostrum and were then removed and some hand-fed colostrum had significantly lower levels than the two other groups. These methods of feeding were not significantly related to mortality rate.

The most evident difference between the 13 low mortality and 17 high mortality herds was the type of maternity area. All 13 low mortality herds used box stalls while 12 of 17 high mortality herds used group pens having 3 - 60 cows in a pen for calving areas. Dampness of the bedding was directly related to the number of the cows in the maternity area and the drier the bedding in the maternity area the lower the herd mortality rate. Herds calving in box stalls had significantly drier bedding than herds calving in groups. Even within the low mortality herds (where all used box stalls) mortality rate decreased as bedding dry matter increased. Thus, in pens and in box stalls calf mortality is higher when bedding is wetter.

Herds using housing specifically built to house newborn calves did not have lower mortality than herds using all other types of housing or herds using makeshift pens in old barns. Population density in the calf house influenced mortality. As the square feet per animal (calves and adults) in the building housing the calves increased, the mortality rate decreased. Bedding was driest when the space per calf in the calf stalls was greatest in both individual and group pens.

Mortality was much less (6%) in herds where the wife cared for calves than in herds that depended on hired labor (21%). However, in herds where the wife cared for calves the herd size was much less (52 cows vs. 270), and the space per animal in the calf barn was twice that found in the herds using hired labor (81 vs. 40 ft^2/animal). These two factors confound the results showing low mortality due to calves being fed by the wife, but more importantly the results definitely indicate that hired labor has less satisfactory conditions under which to raise newborn calves than does the wife.

The studies involving cooperating dairy herds show dairymen need more innovations in the maternity area than in calf housing. Secondly, more colostrum needs to be fed (18-24 lb within 36-48 hr) to minimize the number of calves with low immunoglobulin levels in herds having problems.

INTRODUCTION

The effect of calfhood diseases on dairy industry profits is difficult to accurately determine. Two surveys of Michigan dairymen indicate that mortality up to 2 months of age was 13.5% in 1965 (15) and 17.7% in 1971 (11). Data from Michigan DHIA summaries for 1959 and 1968 show 29% of the dairy cows are culled annually. If this is the case then only 60% of the heifers born (30 of 50 per 100 milking cows) are making it to the milking string, indicating a loss of 40% of the heifers born.

Calves do not receive significant immunity or resistance to disease before birth and must therefore obtain immune proteins (immunoglobulins) from the dam's colostrum soon after birth. Transfer of immunity from colostrum into the intestinal wall and then to the blood of newborn calves can be altered by feeding, environment and management practices. Many researchers have shown that these immune proteins can prevent or alter the infectious diarrhea complex. Large numbers of a bacterium of the *Escherichia coli* type are usually associated with a diarrhea complex. Workers in Nebraska (8, 9) have also determined that two viruses can initiate a diarrhea complex.

Factors such as air temperature, humidity, bedding dampness and cold air drafts, along with lack of colostrum, are believed to reduce the calves' resistance since they place a stress on the calf.

This study was undertaken to investigate immune levels in dairy calves in Michigan herds and to evaluate several variables that may influence immunoglobulin levels within these herds; secondly, to compare herds with distinctly different mortality rates in order to ascertain differences in management, environment, and blood immunoglobulin levels between high and low mortality rates.

EXPERIMENTAL PROCEDURE

Dairymen from 30 Michigan herds phoned MSU personnel when each new calf was born and MSU personnel obtained a blood sample near 48 hr postpartum for measuring immunoglobulin level. Between January and May, 1973, 456 calves were sampled. The herds were previously grouped into a low and high mortality category using 1972 mortality data. Low mortality herds were designated as those with less than 10% mortality (average 8%) and high mortality herds those with greater than 15% mortality (average 23%) within two months after birth. Herds were chosen with the only criteria being high or low mortality rate, more than 40 milking cows, and a location within 100 miles of East Lansing. Immunoglobulin levels were determined using the zinc sulfate turbidity test (ZST) (7).

RESULTS

The average immunoglobulin value was 6.2 in the high mortality herds and 7.5 in the low mortality herds. This difference was not significant, showing the herd's average immunoglobulin level was not related to the mortality rate (Table 1).

The table gives two values for high herds. One objective was to determine if asking the dairyman to participate in obtaining data might change his practices. Thus, some dairymen with high mortality herds (H_1) were asked to record information on time of first colostrum consumption while others (H_2) were not. This recording activity did not cause different levels of immunoglobulin or mortality in calves, which tells us that a dairyman's participation in the study did not cause him to change his usual calf rearing practices.

Table 1. Zinc sulfate turbidity (ZST) values for 48 hr immunoglobulin levels of calves in low (L) and high (H_1 or H_2) mortality herds and for calves that lived or died

Category	ZST Value Mean	ZST Value Range	Number of Calves
9 H_1 herds[(a)]	5.9	0-30	161
8 H_2 herds	6.7	.1-30	118
13 L herds	7.5	.1-27	176
Lived	7.8[(b)]	.1-30	384
Died	5.7	0-25	71

(a) Nine high mortality herds (H_1) recorded, when known, the time from birth to first colostrum feeding while eight high mortality herds (H_2) did not.

(b) The value 7.8 for calves that lived is significantly greater ($P<.05$) than the value of 5.7 for calves that died within 2 months after birth.

Immunoglobulin levels were significantly lower in calves that died than in surviving calves, hence mortality occurred most frequently in calves with lowest immunoglobulin levels as found by English researchers in purchased market calves (6). More calves with low immunoglobulin levels died in high mortality herds (21%) than in low mortality herds (7%). These data suggest that a combination of low levels of immunoglobulin and environmental conditions in high mortality herds increase the odds for neonatal mortality. Calves with low levels in low mortality herds are probably not similarly challenged with disease organisms due to better environment.

Factors Affecting Immunoglobulin Levels

Dairymen in all 13 low and 9 high mortality herds were asked to record, when known, how soon calves received colostrum after birth either by hand-feeding or by nursing. There was no relation between the time to first colostrum in the 138 calves and their 48 hr immunoglobulin levels estimated by the zinc sulfate turbidity test (ZST).

A controlled trial in the MSU herd to determine the effect of time to the first colostrum feeding involved 32 Holstein calves. Four groups of calves were fed initially at 1, 2, 6 or 12 hr postpartum and then fed 4 lb of colostrum every 12 hr after the first feeding up to 38 hr. The initial time from birth to colostrum again did not affect the 48 hr levels estimated by the ZST units. However, the levels at 24 hr postpartum in these calves were higher in calves fed at 1 and 2 hr after birth than in those fed 6 or 12 hr after birth (Figures 1 and 2).

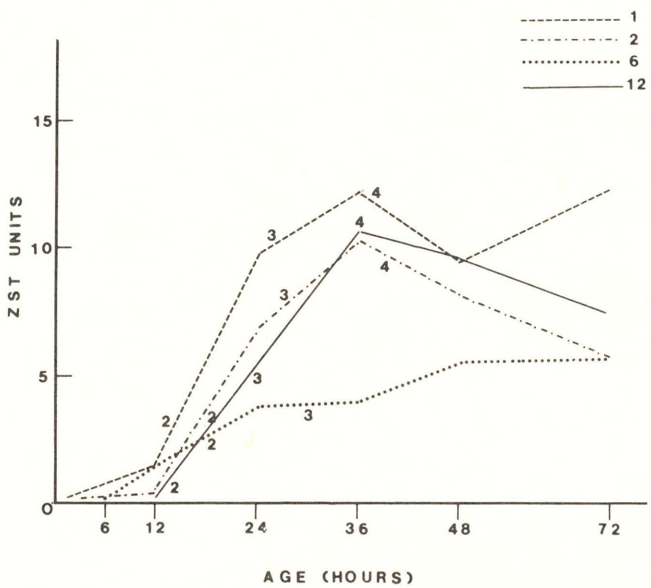


Fig. 1. Serum immunoglobulin levels from 0-72 hr postpartum as estimated by zinc sulfate turbidity (ZST) units for calves receiving 1 lb of colostrum initially at 1, 2, 6 or 12 hr of age as indicated by different lines. Each value represents the mean of 4 calves. Numbers 2, 3, 4 on each line represent time of 2nd, 3rd and 4th colostrum feeding of 4 lb.

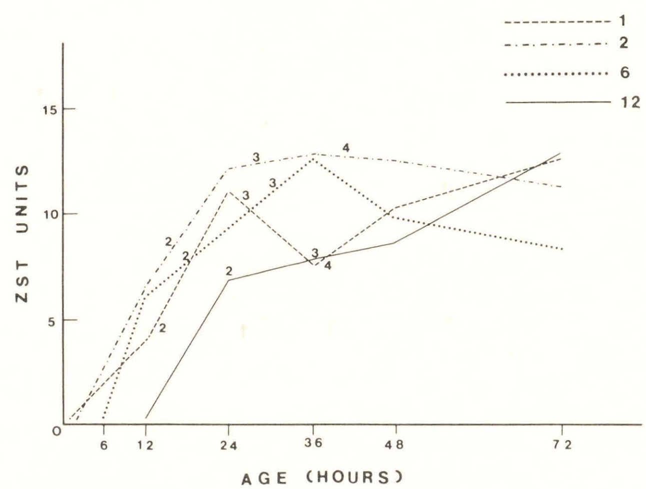


Fig. 2. Serum immunoglobulin levels from 0-72 hr postpartum as estimated by zinc sulfate turbidity (ZST) units for calves receiving 3 lb of colostrum initially at 1, 2, 6 or 12 hr of age as indicated by different lines. Each value represents the mean of 4 calves. Numbers 2, 3 and 4 on each line represent time of 2nd, 3rd and 4th colostrum feeding of 4 lb.

Not all researchers agree that blood immunoglobulin levels can be influenced by the interval from birth to colostrum consumption or by the amount of colostrum fed. Our results help interpret these discrepancies. If immunoglobulin level at 48 hr is considered then neither interval from birth to colostrum consumption nor amount fed the first time influenced that level. Colostrum fed after the first feeding raised blood immunoglobulin values to the same level by 48 hr. However, when immunoglobulin levels at 12 or 24 hr are considered then both amount and interval to first colostrum influenced the blood level. Thus feeding colostrum soon after birth and feeding larger amounts tend to increase blood immunoglobulin levels from 12-24 hr of age. These greater levels at this age are probably helpful.

There was a significant positive correlation between interval from birth to colostrum consumption and mortality in four high mortality herds ($r = +.35$). However, these data only included 39 calves and more conclusive evidence is needed to substantiate this relationship. Other research (3) has shown that survival is high when colostrum is fed before pathogenic bacteria are given to calves, but if pathogenic bacteria are fed to calves before colostrum then survival is much lower. The important point then is to feed colostrum early and establish high immunoglobulin levels before bacteria enter the digestive tract. Early feeding of colostrum is most important in high mortality herds where pathogenic bacteria and environmental stresses are more prevalent than in low mortality herds.

Dairymen recorded, when known, time calves remained with the dam. There was no meaningful relation between calf mortality and the time cow and calf remained together ($r = -.14$, $n = 106$).

Amount of colostrum fed was found to be an important variable affecting immunoglobulin levels. Half of the 32 Holstein calves in the MSU herd study were initially fed 1 lb of pooled colostrum from 10 cows while the other half were fed 3 lb. All calves received 4 lb of pooled colostrum every 12 hr after the initial feedings. Figures 1 and 2 show blood immunoglobulin levels from 0-72 hr for these calves. Calves fed 3 lb initially had higher levels at 12 hr than calves receiving only 1 lb (5.6 vs. 1.2) and also at 24 hr (9.9 vs. 6.5). However by 48 hr the difference due to the initial amount fed was not significant. The second feeding increased the immunoglobulin levels in the calves initially fed 1 lb by a factor of 6 between 12 and 24 hr but only by a factor of 2 in calves that received 3 lb initially. Also, calves in another experiment that received 3, 5, 6 or 7 lb of colostrum by 18 hr had stepwise increased levels of immunogolbulin in their blood at 24 hr. All had levels lower than calves left on the cow. Calculations indicated that total colostrum fed per pound of body weight had the greatest influence on the 48 hr blood immunoglobulin levels. For instance, calves fed 1 lb initially at 6 hr and 4 lb at 18 and 30 hr for a total consumption of 9 lb colostrum (1+4+4) had low values of 5.0 ZST units at 48 and 72 hr; while calves fed a total of 15 lb colostrum (3+4+4+4) had values of 10 to 11 ZST units at 48 and 72 hr (Fig. 1). The total amount of immunoglobulin fed would depend upon the immunoglobulin concentration in the colostrum and the total amount of colostrum fed. We found first colostrum postpartum to have immunoglobulin levels twice those found in second milking colostrum. Researchers at Oklahoma State University (2) also found a highly significant correlation (r = +.82) between the amount of colostral immunoglobulin fed per unit of calf weight and the 24 hr blood immunoglobulin levels. Work by Kruse in 1970 (4) indicated that the amount of colostrum fed was more influential upon immunoglobulin levels than the time to the first feeding.

Method of Feeding Colostrum

The amount, time and concentrations of immunoglobulin in colostrum fed are factors that influence the immunoglobulin levels which in turn are related to mortality in Michigan dairy herds. Hence, the method of feeding colostrum during the first two days of life becomes important.

Nine Holstein calves in the MSU herd were allowed to remain in box stalls with their dam for 36 hr postpartum while nine other Holstein calves were separated 15 minutes after birth and hand-fed their dam's colostrum using a nipple bottle. Calves were fed 2 lb at 1 hr and 4 lb at 12, 24 and 36 hr. Figure 3 shows calves left with their mother had higher average immunoglobulin levels than hand-fed calves throughout the first 2 weeks of life.

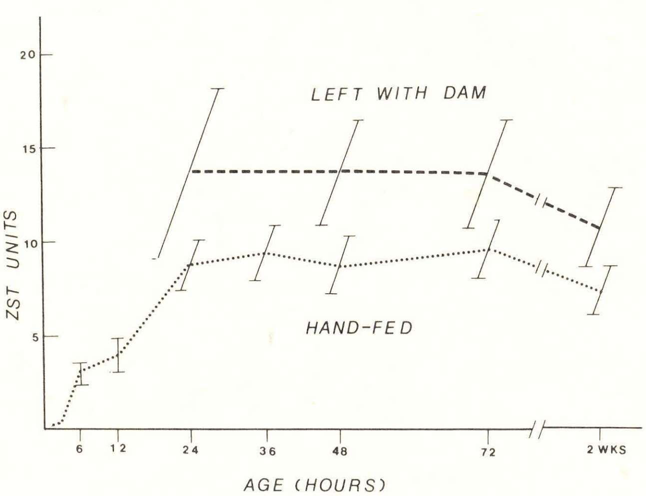


Fig. 3. Serum immunoglobulin levels from 1 hr to 2 weeks of age as estimated by zinc sulfate turbidty (ZST) units for 9 calves hand-fed colostrum up to 36 hr postpartum and 9 calves remaining with their dam to 36 hr postpartum. Standard errors are represented by vertical lines.

However, in this experiment the differences were not significant because of the large variation for immunoglobulin levels in calves left with their dam. Selman and coworkers (13) showed that muzzled calves left with the dam and fed identical amounts of colostrum as separated calves possessed significantly higher immunoglobulin levels than the separated calves. They suggested a maternal effect caused by the presence of the dam. They (14) also found that calves allowed to nurse at 6 and again at 12 hr consumed colostrum in amounts equal to 10% of their body weight. In another experiment 25% of all calves observed did not voluntarily nurse within 8 hr postpartum (12). Of the 75% that did nurse, the average time to first suckling was 4 hr postpartum. From these and our own observations, one concludes that the mothered calves had higher levels due to: 1) greater colostrum consumption than separated calves (14 lb), and 2) presence of the dam, and 3) large variation within the mothered calves exists due to differences in amounts of colostrum nursed.

Calves allowed to remain with the dam did not obtain colostrum sooner than those separated and hand-fed at 1 hr postpartum based on observations during this study and Selman's work. Therefore, time to initial colostrum feeding in good environmental conditions becomes secondary to other factors.

The field data compare closely to these results. To measure the "maternal effect" the relationship between the time the calf remained with the dam and the 48 hr immunoglobulin level was calculated. In 11 low mortality herds a low but significant positive correlation existed (r = +.30) indicating greater levels with longer time on the dam. However, in eight high mortality herds leaving calves with the dam longer did not significantly increase blood immunoglobulin levels (r = +.13). The reason for this difference due to herd type is not known but may be due to differences in maternity environment which will be mentioned later.

Methods employed by dairymen to feed colostrum during the first 36 hr were placed into three categories. One allowed the calves to remain with the dam 24 to 48 hr. These herds had the highest immunoglobulin levels (Group A). A second removed the calf from the cow prior to 12 hr after birth. Assuming most of the calves had not yet nursed, the dairymen fed colostrum by hand (Group B). These herds had slightly and insignificantly lower levels than Group A. The third (Group C) left the calves with the dam for slightly more than 12 hr, removed the calves and hand-fed some colostrum. These herds had significantly lower immunoglobulin levels than the other two groups (Table 2). Dairymen in Group C believed that during the 12 hr with the cow, most calves (80%) obtained their first colostrum from the dam and the rest received first colostrum when they were hand-fed. An average of 7 lb of colostrum was hand-fed within 36 hr by dairymen in Group C; whereas, in Group B an average of

10 lb was hand-fed. The main difference between Groups A and C was time the calf was left with the cow; in Group A any calf that did not get colostrum by 12 hr had further chances but in Group B most dairymen fed no more colostrum after separating cow and calf. Calves in Group A probably consumed more colostrum than those in Groups B and C; and those in B more than those in C. There was a high correlation (r = +.55) between immunoglobulin levels and amounts of colostrum hand-fed within 36 hr in the eight low mortality herds in Groups B and C. However, due to the low number of herds the correlation was not significant.

Table 2. Zinc sulfate turbidity values in calves from three methods of colostrum feeding in Michigan dairy herds

Principle Method of Colostrum Feeding	Colostrum Administration: Time with dam	First source[a]: Cow	First source[a]: Hand	Amount[b] in 36 hr	ZST Value	Number: Herds	Number: Calves
	hr	%	%	lb			
A Nurse	>24	93	7	0	8.6 [c]	6	83
B Hand-feed	1-12	13	87	10	7.3[d]	14	211
C Nurse + hand-feed	±12	80	20	7	4.9[e]	10	162

[a]Percent of calves receiving their first colostrum by nursing or hand feeding. Average estimates made by dairymen.

[b]Average amount colostrum hand-fed when hand-feeding was practiced.

[c]Value is significantly greater than e; P< 005.

[d]Value is significantly greater than e; P<.05.

Environment, Management and Mortality

The evaluation of two groups of herds having distinctly different mortality rates indicated that maternity area was of significant importance in determining mortality rate. All 13 low mortality herds were using box stalls but only four high mortality herds used box stalls. Twelve other high mortality herds had cows calving in large group pens of 3 to 60 cows each. Table 3 shows the number of herds and mortality rate based on type of maternity area used. In 1972 the herds were classed as high or low by their mortality rate and the data showed about 25% mortality in herds using group pens as the calving area but only 10% in herds using box stalls. The mortality rate from January to May 1973 averaged 29% for herds having group pens, while only 6% mortality was noted in herds using box stalls.

Table 3. The relation of mortality to the type of maternity area (box stall vs. group) in 30 Michigan dairy herds

Maternity System	Mortality Group: Low	Mortality Group: High[a]	Mortality Rate: 1972	Mortality Rate: 1973
	Number of Herds		%	%
Box stalls	13	4	10[b]	6[d]
Group pens	0	12	25[c]	29[e]

[a]One herd calved cows in tie stalls.

[b]The value is significantly greater than c; P<.001.

[d]The value is significantly greater than e; P<.005.

During the study dry matter content was determined from several samples of bedding in the calving area of these herds. Table 4 shows the average dry matter percent of bedding from high and low mortality herds and for box stalls or group pens; group pens averaged only 35% dry matter but box stalls averaged 67%. As the mortality rate decreased the dryness of the bedding increased (r = -.72). This was not only true for all 29 herds, but also within the 13 low mortality herds which all used box stalls (r = -.72). These relationships clearly show that high mortality was related to wet bedding in the maternity area.

In both 1972 and 1973 mortality rates increased as the number of cows in the maternity area increased (r = +.49 and r = +.63). As population density of the maternity area increased maintenance of dry bedding became more difficult and appeared responsible for the high calf mortality.

The use of sawdust for bedding in the maternity area is questionable. Mortality rate for calves on sawdust was greater than for those on straw and average dry matter of sawdust in maternity areas was only 45 to 48%. One dairyman noted that newborn calves would eat the sawdust and sawdust consumption by calves was also noted during experiments at MSU. Sawdust easily adheres to the mouth and may carry pathogenic organisms into the digestive tract.

Table 4. The relationship of the dry matter percent of bedding in the maternity area to mortality group and type of calving area in 30 Michigan dairy herds

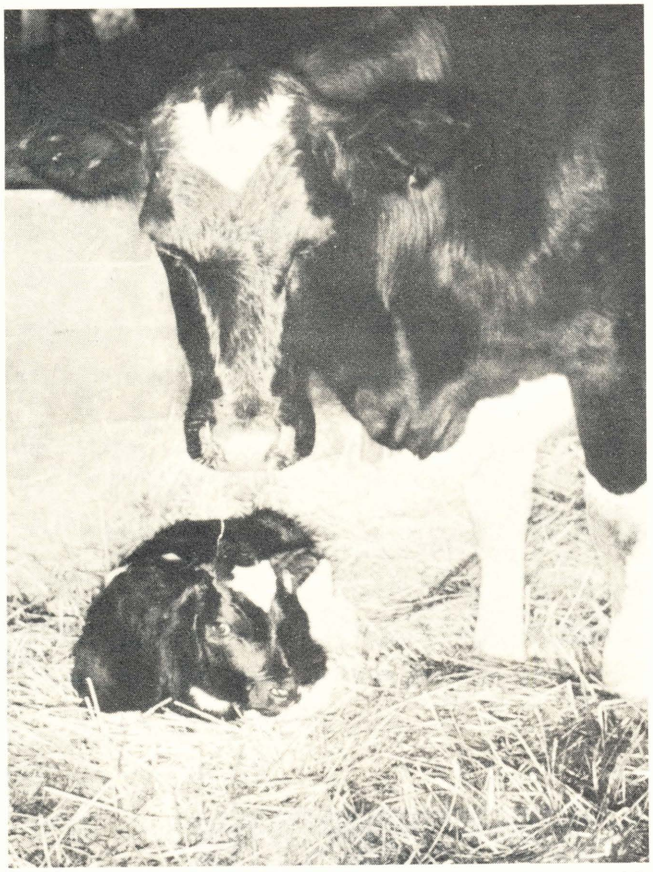
Mortality Group: Low	Mortality Group: High	Maternity Area: Low	Maternity Area: High
Maternity area bedding dry matter percent			
69[a]	42[b]	67[a]	35[b]

[a]The value of 69 or 67 is significantly greater than the value 35 or 42[b] at P<.001.

This is an example of a reasonable box stall area for cows to calve in, with ample space for cow and calf.

This group maternity area had ample space per cow but bedding was too wet.

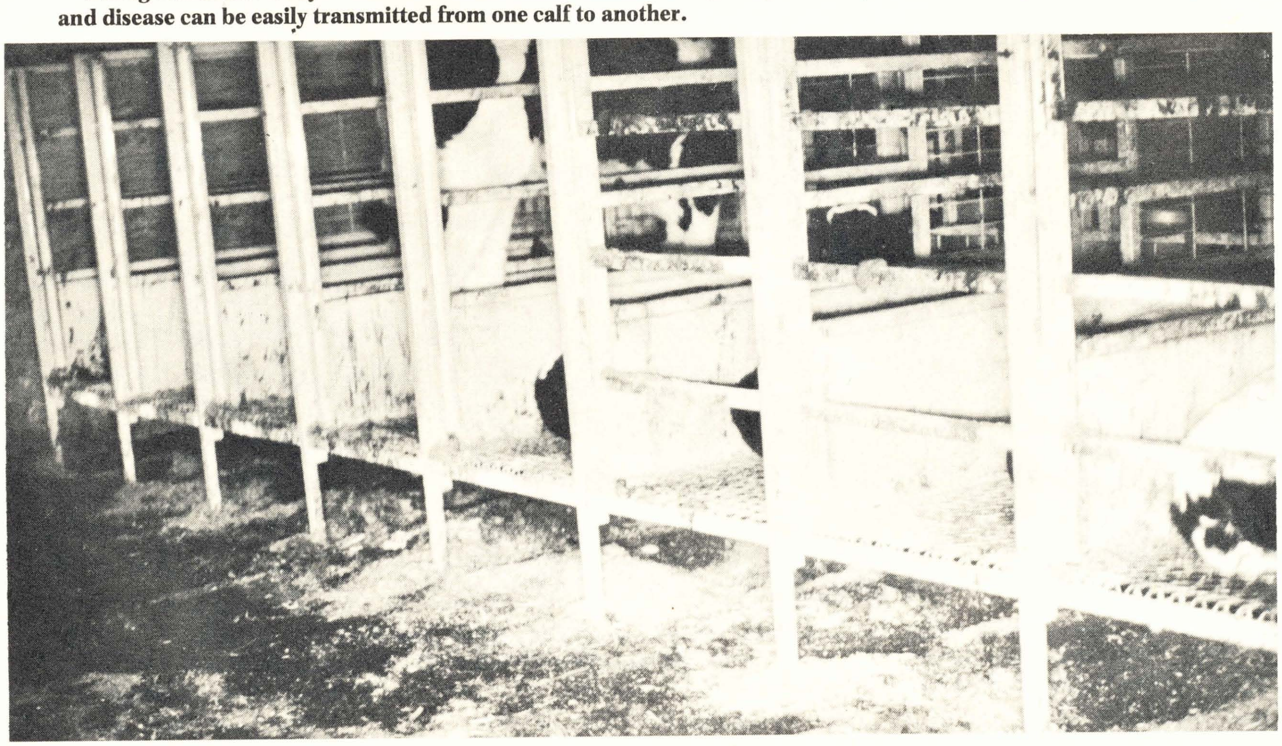
Four of these sample beddings from various types of maternity pens had 80% or higher amounts of dry matter (D.M.) while two had too low a level (48% and 56%) of D.M. Calves born on bedding this wet had a high mortality rate.



This cow and calf are in a desirable maternity pen, with ample space and dry bedding.

This cow and calf are in an undesirable maternity area, with very wet bedding. The calf will likely get this kind of filth into its mouth before nursing. Calves born in this type of area had a high death rate.

Young calves lose body heat to these cold metal screens. Frequently humidity is high in this type of calf facility and disease can be easily transmitted from one calf to another.



Temperature and Humidity

The temperature and humidity of calf barns and maternity areas were taken periodically during visits to the dairy herds. The average calf barn temperatures and their deviation from the outside temperature indicated no difference between high and low mortality herds (average 55° vs. 54°F—deviation 6.1 vs. 6.6°F). However, heated calf barns averaged six degrees higher than non-heated barns. The average relative humidity was 6% lower (61 vs. 67) in low than in high mortality herds and 4% lower in heated barns than in unheated barns. Little difference existed in temperature and relative humidity in the maternity areas of high and low mortality herds. More important, however, would be the amount of daily fluctuation in temperature and humidity which would increase stress.

Personnel Feeding Calves

Table 6 stratifies the mortality rates by the type of personnel feeding the calves. As in other reports, lowest mortality was recorded where the wife fed the calves and highest mortality where hired labor fed calves. However, this is a confounded situation since the wife had two important factors in her favor. First, average herd size was only 52 cows versus 270 cows in herds using hired labor; and second, space per animal was 81 ft^2 where the wife fed calves compared to only 40 ft^2 where hired labor fed calves. Thus, hired labor was given less satisfactory systems with which to rear calves.

Table 6. Calf mortality rate related to person feeding herd size and population density

Person Feeding Calves	Mortality Rate 1972	1973	Herd	Milking Cow	Ft^2/animal (Calf Barn)[a]
	%	%	#	#	
Wife	7	0	3	52	81
Wife & owner	18	47	2	75	79
Owner	18	10	14	158	64
Owner & hired	12	11	6	146	49
Herdsman	21	36	2	176	49
Hired	22	26	3	270	40

(a) Ft^2 per animal in building housing the calves: total area ÷ total animals (calves + adults) in that barn.

Implications of Study

Herds with a high mortality rate can do two things to lower it—reduce the number of calves that have low immunoglobulin levels and establish the conditions that exist in low mortality herds, which in this study involve the maternity area.

The method of feeding colostrum is important because it affects the amount of immunoglobulin the calf receives and is able to absorb, which strongly influences the immunoglobulin levels in blood and mortality rate. Although none of the three feeding methods employed by dairymen in this study completely eliminated low immunoglobulin levels, those herds that allowed the calf to remain with the dam for 24-48 hr had the highest levels. Apparently some calves left with the dam do not nurse and obtain adequate amounts of colostrum within 24 hr; thus, longer contact with the cow or mandatory hand-feeding are needed to insure high immunoglobulin levels. Some calves may neither nurse sufficiently nor absorb immunoglobulins efficiently due to conditions in the maternity area and/or poor mothering effect. Calves taken from their dam at 12 hr (Group C) and hand-fed a total of 7 lb colostrum between 12 and 36 hr had the lowest values but calves taken away at the same time (Group B) and hand-fed a total of 10 lb colostrum had higher immunoglobulin levels. The important difference is that dairymen in Group C believed that 80% of their calves received first colostrum from the dam and probably hand-fed less colostrum than those in Group B who believed only 13% nursed the cow before separating at 12 hr.

This research did not try to identify the organism causing calf mortality since this varies according to location and time. The real objective was to investigate conditions which permit mortality year after year. Wet bedding due to overcrowding in the maternity area appears strongly related to mortality rate. This dampness in both group calving areas and box stalls increases heat loss from newborn calves providing additional stress. The group pens were also more difficult to keep clean, which together with the dampness of the bedding provided an ideal condition for proliferation of disease organisms. The group calving situation may destroy the desirable maternal effect of intimate cow-calf interaction which may act to increase blood immunoglobulin levels. Colostrum consumption may also be decreased by cow competition where several cows attempt to claim the calf and where the calf might be unable to find the dam when she leaves to compete for food. One should not have been surprised that dampness of bedding in the maternity area was strongly related to calf mortality, yet this fact appears to have escaped previous investigators and has not been emphasized in recommended dairy procedures.

Suggested Course of Action

Instead of naming a long list of recommendations that dairymen should follow, we suggest that two factors be evaluated in herds where high calf mortality exists. First, examine your maternity area and second, examine your method of feeding colostrum to newborn calves and the amounts received.

Evidence from this study suggests that innovations in maternity areas are needed more than improvements in calf housing. Box stalls with dry bedding that isolate the cow and newborn from other cows are the first step in assuring low calf mortality.

When adequate box stall facilities are available the calf should be left with the dam for 24-48 hr. Additionally each calf should be hand-fed 6-8 lb of colostrum when 2-8 hr old. Don't assume that the calf has or will nurse on its own. Dairymen may repeat colostrum feeding every 12 hr for the first three days. If over-feeding is feared or calves refuse to consume this quantity of colostrum, reduced amounts should be fed more frequently. A total of 18-24 lb colostrum within 36-48 hr is a good target. To test this system, dairymen may want to first use bull calves, then adopt it for heifers if satisfied. Other researchers (10, 16), indicated few adverse effects occurred by overfeeding colostrum, particularly if a nipple system was used. First colostrum (less than 12 hr post calving) has twice the immunoglobulin content of the second milking. Later milkings have much less. Thus, saving all the first and second milking colostrum for feeding to newborn calves is necessary to establish high blood immunoglobulin levels in calves. Milk from different animals can be pooled for this purpose. Even though third to sixth milkings contain reduced immunoglobulin levels all contain immunoglobulins that specifically act within the intestinal tract to reduce effects of harmful bacteria.

Calves born in a group pen or other unsatisfactory maternity area should be removed as soon as possible (1-2 hr) to a dry calf pen and hand-fed 18-24 lb colostrum (first or second milking) within 36-48 hr. In all cases feeding of colostrum for at least 48 hr or more after birth is a must for rearing calves successfully.

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