EFFECT OF BREED ON THE INCIDENCE OF CALF MORTALITY UNTIL WEANING IN THE FRIESIAN AND JERSEY AND ITS RELATIONSHIP TO COLOSTRUM AND ROTAVIRUS STATUS

by

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SUMMARY

The incidence of calf mortality until weaning at eight weeks of age was studied in 321 Jersey and 390 Friesian calves of which 14 Jersey and 72 Friesian were colostrum-deprived. Rotavirus was determined by the electron microscopic examination of faeces and serum gammaglobulin was assessed qualitatively by the sodium sulphite turbidity test.

Rotavirus in faeces of calves at the time of entry had no effect on mortality rate. There was a higher mortality rate in calves having low serum gammaglobulin levels compared with calves showing evidence of satisfactory uptake of colostrum antibodies. Thus, in order to eliminate this effect, comparison of mortality rates between Jersey and Friesian breeds were done within high gammaglobulin, hypogammaglobulin and agammaglobulin groups. A significant difference between breeds was seen only in the last group of colostrum-deprived calves.

INTRODUCTION

Calf morbidity and mortality results mainly from septicaemia, neonatal diarrhoea and respiratory disease. The enteropathogenic agents causing disease range from viruses such as rotaviruses and coronaviruses, bacteria such as Escherichia coli, Clostridium perfringens type A, B and C, Salmonella species and protozoa such as Cryptosporidium species. The importance of colostral immunity in conferring resistance to such bacterial and viral agents is well recognised. The newborn calf obtains passive immunity to disease from its dam by sucking of colostrum. Colostrum contains three major immunoglobulins which are IgG, IgM and IgA, of which IgG is the most abundant. The main factors determining the immunoglobulins absorbed by the calf are the concentration of immunoglobulin in first colostrum, the amount of colostrum consumed by the calf and the time of first feeding. The maximum ability to absorb globulins from the small intestines lasts for only about six to eight hours and absorption continues up to 24 hours after birth (Blood, Radostits & Henderson, 1983). Thereafter the calf's intestines lose the ability to absorb the essential immunoproteins in the colostrum. The peak concentration of immunoglobulins in the calf's blood is attained 18 to 24 hours after birth and thereafter the level declines (Andrews, 1983). Testing of calves at markets or on farms to determine their serum immunoglobulin status is increasingly becoming a common practice prior to purchase and commercial tests are now available for this purpose.

Circulating antibodies prevent systemic disease, but other mechanisms are involved in protection against gut infections. As well as immunoglobulins, the cells in colostrum are thought to play a role in the gut; and breed immune responses could also be involved.

The role of disease agents and their effect on calf morbidity and mortality
is generally well understood. However, the contribution of breed genotype to
such disease processes is not well documented. The object of this study was to
elucidate this effect in relation to two breeds, the Jersey and Friesian, at
adequate levels of colostrum intake, low levels (hypogammaglobulinaemia) and no
colostrum feeding (agammaglobulinaemia).

The effect of rotavirus infection and serum gammaglobulin level on mortality
rates of calves was also studied. Rotaviruses are intestinal pathogens trans-
mittted by the faecal-oral route and cause acute gastroenteritis in calves within
four or five days post-natally. On occasion the infection results in high
mortality up to 30 to 40 per cent in farm outbreaks (Flewett and Woode, 1978).
Rotaviruses are present in large numbers in the faeces and they can be detected
by direct electron microscopy of untreated faeces. More recently, the enzyme-
linked immunoabsorbent test (ELISA test) has been used to detect calf rotaviruses.
The pathogenesis of the rotavirus has been demonstrated experimentally. The
microvilli of the brush border of the small intestines becomes shortened, ragged
or may completely disappear. During the period of acute disease, the damage to
the intestines may be severe due to almost total destruction of the villi in
some areas. The epithelial cells of the brush border which synthesise
disaccharides are destroyed. The absence of these cells causes lactose and other
disaccharides to remain in the lumen of the alimentary canal and so cause an
osmotic gradient drawing body fluid into the alimentary canal. The retention of
lactose is the main cause of diarrhoea, dehydration and death in calves.

MATERIALS AND METHODS

Three hundred and seven Jersey and 318 Friesian conventionally born calves,
mainly males, were purchased within a few days of birth during the period 1976 to
1981. All the Jersey calves were bought from 13 private farms. The majority of
Friesian calves were supplied from two markets and a small number from 12 private
farms.

A small trial batch of 14 colostrum-deprived Jersey calves of both sexes
were purchased in March and April 1977 from 5 private farms to explore the
feasibility of rearing such calves in isolation under conventional conditions.

One of the laboratory's own dairy production farms supplied 72 colostrum-
deprived Friesian calves, mainly females, to establish a specific-pathogen-free
herd using bovine virus diarrhoea as a marker. The male colostrum-deprived
calves were used for experiments. The calves were reared at the Central Veterinary
Laboratory, Weybridge and the adjoining farms. There were some differences in
housing between some groups as colostrum-deprived calves were reared in isolation
pens. Samples of blood and faeces were taken from the calves soon after arrival.
The Veterinary Investigation Centre (VIC), Weybridge carried out a qualitative
assessment of this serum gammaglobulin using the sodium sulphite turbidity test
(SSTT). The Department of Virology conducted the examination of faeces under the
electron microscope and confirmed the presence or absence of rotavirus. The
conventional calves were fed milk or a milk substitute, a concentrate mixture
containing one part flaked maize, one part oats and one part calf rearing cake and
hay until they were weaned at eight weeks of age. Colostrum-deprived calves
received sterilised milk in place of ordinary milk and were supplemented with
vitamins, which were likely to be destroyed by heat sterilisation. Sick calves
were treated and most of those that died were submitted to the VIC Centre for
post-mortem examination. Sera classified as negative, weak positive, inadequate,
trace, slight trace, low level, low and doubtful were grouped as gammaglobulin
negative in this study. All other sera with satisfactory levels of gammaglobulin
were regarded as gammaglobulin positive. A log linear model based on the
binomial distribution was used to identify (1) the breed and rotavirus effects in conventionally born calves and the Chi-square test with Yates correction for continuity was used for comparing mortality rates between the following groups (2) gammaglobulin + and -ve groups within breeds (3) Jersey vs Friesian within gammaglobulin +ve and -ve groups and (4) Jersey vs Friesian within the colostrum-deprived group.

RESULTS

The log linear analysis indicated that the mortality rate of conventionally born calves was not affected by either rotavirus or breed (Table 1).

The incidence of hypogammaglobulinaemia in the conventional Jersey calves was not different from that of similar Friesian calves (Table 2). There was a higher mortality rate in conventional calves having low serum gammaglobulin levels compared with calves showing evidence of satisfactory uptake of colostrum antibodies. This difference was statistically highly significant within the Jersey and Friesian breeds (Tables 3 and 4). Thus, in order to eliminate this effect, a comparison of mortality rates between Jersey and Friesian breeds was carried out within each type of serum gammaglobulin group (Tables 5 and 6). Although Friesian calves with hypogammaglobulinaemia apparently survived better than similar Jersey calves, this difference was not statistically significant. However, this trend diverged markedly in the colostrum-deprived class and the difference in mortality rate between the Friesian and Jersey breeds was statistically highly significant (Table 7). Thirteen out of 14 colostrum-deprived Jersey calves died. Records show that eight calves died during the first week of life and two others before two weeks of age. Diarrhoea and dehydration were the clinical symptoms observed in all cases of morbidity and mortality. Post-mortem reports of 10 calves show that non-haemolytic Escherichia coli was present in all organs examined in eight cases and rotavirus and/or coronavirus was observed in five cases.

**TABLE 1**

<table>
<thead>
<tr>
<th>Breed</th>
<th>Rotavirus status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Jersey</td>
<td>7/52 (13.5%)</td>
</tr>
<tr>
<td>Friesian</td>
<td>7/41 (17.1%)</td>
</tr>
</tbody>
</table>

Rotavirus $X^2 = 0.152$, df = 1, $P>0.05$

Breed $X^2 = 0.951$, df = 1, $P>0.05$

Among the Jersey group there were five Jersey-Hereford, one Jersey-Aberdeen Angus and one Jersey-Charolais crossbred calves, and among the Friesian group there was one Friesian-Jersey calf and one Friesian-Hereford calf.
### TABLE 2

Incidence of hypogammaglobulinaemia in conventional calves.

<table>
<thead>
<tr>
<th>Gammaglobulin -ve</th>
<th>Gammaglobulin +ve</th>
<th>Total</th>
<th>% Gammaglobulin -ve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jersey</td>
<td>98</td>
<td>209</td>
<td>307</td>
</tr>
<tr>
<td>Friesian</td>
<td>124</td>
<td>194</td>
<td>318</td>
</tr>
</tbody>
</table>

$X^2 = 3.109, \ df = 1, P > 0.05$

### TABLE 3

Relationship between gammaglobulin status and mortality rate in conventional Jersey calves.

<table>
<thead>
<tr>
<th></th>
<th>Dead</th>
<th>Alive</th>
<th>Total</th>
<th>% Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gammaglobulin -ve</td>
<td>34</td>
<td>64</td>
<td>98</td>
<td>34.7</td>
</tr>
<tr>
<td>Gammaglobulin +ve</td>
<td>18</td>
<td>191</td>
<td>209</td>
<td>8.6</td>
</tr>
</tbody>
</table>

$X^2 = 30.430, \ df = 1, P < 0.001$

### TABLE 4

Relationship between gammaglobulin status and mortality rate in conventional Friesian calves.

<table>
<thead>
<tr>
<th></th>
<th>Dead</th>
<th>Alive</th>
<th>Total</th>
<th>% Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gammaglobulin -ve</td>
<td>31</td>
<td>93</td>
<td>124</td>
<td>25.0</td>
</tr>
<tr>
<td>Gammaglobulin +ve</td>
<td>15</td>
<td>179</td>
<td>194</td>
<td>7.7</td>
</tr>
</tbody>
</table>

$X^2 = 16.862, \ df = 1, P < 0.001$

### TABLE 5

Breed differences in mortality rates within high gammaglobulin level group in conventional calves.

<table>
<thead>
<tr>
<th></th>
<th>Dead</th>
<th>Alive</th>
<th>Total</th>
<th>% Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jersey</td>
<td>18</td>
<td>191</td>
<td>209</td>
<td>8.6</td>
</tr>
<tr>
<td>Friesian</td>
<td>15</td>
<td>179</td>
<td>194</td>
<td>7.7</td>
</tr>
</tbody>
</table>

$X^2 = 0.0197, \ df = 1, P > 0.05$
TABLE 6

Breed differences in mortality rates within low gammaglobulin level group in conventional calves.

<table>
<thead>
<tr>
<th>Breed</th>
<th>Dead</th>
<th>Alive</th>
<th>Total</th>
<th>% Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jersey</td>
<td>34</td>
<td>64</td>
<td>98</td>
<td>34.7</td>
</tr>
<tr>
<td>Friesian</td>
<td>31</td>
<td>93</td>
<td>124</td>
<td>25.0</td>
</tr>
</tbody>
</table>

\[ X^2 = 2.038, \text{df} = 1, P > 0.05 \]

TABLE 7

Breed differences in mortality rates of colostrum-deprived calves.

<table>
<thead>
<tr>
<th>Breed</th>
<th>Dead</th>
<th>Alive</th>
<th>Total</th>
<th>% Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jersey</td>
<td>13</td>
<td>1</td>
<td>14</td>
<td>92.8</td>
</tr>
<tr>
<td>Friesian</td>
<td>23</td>
<td>49</td>
<td>72</td>
<td>31.9</td>
</tr>
</tbody>
</table>

\[ X^2 = 15.454, \text{df} = 1, P < 0.001 \]

DISCUSSION

The number of calves representing the two breeds under investigation are reasonably comparable and sufficiently large to make these results meaningful. One of the limitations of this study was that the serum immunoglobulin level was not quantified and there may be a likelihood of slight operator differences in the classification of SSTT results. However, the comparisons between breeds of calves were made under similar management conditions during rearing, although their source of origin was different. Friesian calves mainly purchased from markets were subjected initially to more stress and had an apparently higher incidence of hypogammaglobulinaemia than Jersey calves. If stress occurred during the normal period of intestinal permeability up to 24 hours post-nataally, this could interfere with immunoglobulin absorption. Heat stress has been shown to depress colostral Ig absorption in the newborn calf (Stott, 1980). The other factors affecting serum immunoglobulin levels are breed, parity and dry period. Limited studies have shown that breeds may differ in colostral Ig concentrations and in Ig concentrations of blood serum in calves suggesting genetic differences. Muller and Ellinger (1981) compared colostral Ig concentrations among five dairy breeds under similar management conditions in the Pennsylvania State University herd. The Ig level in colostrum from Jersey was significantly higher than that of Holstein but the number of animals was too small to be absolutely confident of this finding. In this same study, parity was another factor that influenced the level of Ig in colostrum. Heifers that calved were found to have a lower total colostral Ig and IgA content than cows in their third and later parities. This was thought to be associated with a reduction in the levels of antibodies against specific diseases, which in turn provided an explanation for the greater losses observed among the calves of first-calf heifers.

A very short dry period has been shown by Logan, Meneely and Lindsay (1981) to have a very marked depressant effect on the Ig content in their colostrum and also adversely affect the serum Ig content of their calves suckling them. However, the number of experimental animals was too few to be confident of these results.
The present study supports the findings of previous reports that calves with hypogammaglobulinaemia have a higher risk of mortality than calves with adequate levels of serum gammaglobulin. Thus, feeding of colostrum soon after birth, while the intestines remain permeable to antibodies, is a particularly important management practice to recommend to farmers in order to ensure the good health of calves.

There is some indication that the mortality rate of Jersey calves is higher than the Friesian calves when there is hypogammaglobulinaemia, although this difference did not approach statistical significance. This trend was clearly evident in the attempt to rear a small number of totally colostrum-deprived Jersey calves when the mortality rate drastically rose to 93 per cent. In contrast, large numbers of colostrum-deprived Friesian calves have been quite successfully reared under similar management conditions at the CVL. Leech, Macrae and Menzies (1968) have reported a similar high mortality where all 13 colostrum-deprived Jersey calves died but five out of six colostrum-deprived Friesian calves survived. Thus, in the absence of protection by colostral antibodies there are indications of variation between breeds in their liability to disease. This may be due to variation in their ability to resist infection or the effects of infection once it has occurred. The fact that there was no evidence that rotavirus contributed to calf mortality is in agreement with results reported by other workers.

REFERENCES


ACKNOWLEDGEMENTS

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