The association of neonatal calf diarrhoea with and without dehydration on milk feeding and activity variables in young pre-weaned artificially reared calves

Riley, BB; Duthie, C-A; Mason, CS; Corbishley, Alex; Haskell, MJ

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assigned using the SILVA database. Data were further analysed using the *R* packages *Phyloseq* and *MaAsLin2*, and the Benjamini-Hochberg procedure (q) was used to correct for false discovery rate. Amplicon Sequence Variants (ASVs) found associated with HS were checked for normality and homogeneity of variance by histograms, qqplots, and formal statistical tests as part of the UNIVARIATE procedure in SAS 9.4. A Spearman rank-order correlation for non-parametric data was preformed to determine correlations between ASVs and calf performance data including faecal scores. Correlations with a P-value less than 0.05 were considered significant.

Results

The mean day post-birth for diarrhoea was d22 (SE 0.70); 53% of calves had a diarrhoea incident. There was no difference ($P > 0.05$) in sIgG between healthy and diarrheic calves (Healthy: 43.4 (SE 1.82) g/L; Diarrheic: 37.6 (SE 2.52) g/L). Based on PERMANOVA analysis, calf breed ($P = 0.08$), colostrum source ($P = 0.31$), and passive immune status ($P = 0.21$) had no effect on composition of the faecal microbiota. At disease manifestation, diarrheic calves had reduced bacterial diversity compared to healthy calves, and 24 ASVs were significantly associated ($q < 0.05$) with HS. *Bifidobacterium* (6.4%) was the dominant genera in healthy calves, while *Alloprevotella* (13.7%) was the dominant genera in diarrheic calves at disease manifestation. *Alloprevotella* had strong negative correlations ($P \leq 0.0001$) with *Faecalicoccus, Akkermansia,* and *Intestinibacter*, and a moderate negative correlation ($P \leq 0.01$) with *Bifidobacterium, Prevotella_7, Flavonifractor,* and *Dialister. Bifidobacterium* had a strong positive correlation ($P \leq 0.0001$) with *Prevotella_7* and moderate positive correlations ($P \leq 0.01$) with *Collinsella, Faecalicoccus, Flavonifractor, Dialister,* and *Intestinibacter*. A weak negative correlation was observed between sIgG and *Alloprevotella* and moderate positive correlations with *Prevotella_7* and *Faecalicoccus*. Faecal Score displayed moderate negative correlations ($P \leq 0.01$) with *Bifidobacterium, Prevotella_7, Faecalicoccus, Dialister,* and *Intestinibacter.* A strong positive correlation between faecal score and *Alloprevotella* was observed. No significant correlations were found between ASVs and average daily gain.

Conclusion

The reduction in microbial diversity observed in diarrheic calves enabled the proliferation of other bacterial genera. *Alloprevotella*, has not previously been associated with diarrhoea in calves, and is considered a part of the normal intestinal flora. The proliferation of *Alloprevotella* appears to be negatively associated with other genera that are known to be beneficial to gut health (e.g. *Bifidobacterium, Faecalicoccus*). The correlations between ASVs significant at disease manifestation show the relationship between microbes in the hindgut and the influence they have on each other as their presence changes within the hindgut.

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53. The association of neonatal calf diarrhoea with and without dehydration on milk feeding and activity variables in young pre-weaned artificially reared calves

B. Riley [a,b], C. Duthie [a], C. Mason [b], A. Corbisheley [b], M. Haskell [a]

[a] Scotland's Rural College (SRUC), Edinburgh, Scotland, United Kingdom
[b] Royal (Dick) School of Veterinary Science, University of Edinburgh, Edinburgh, Scotland, United Kingdom

Presenting author.
Bethan Riley. briley@sruc.ac.uk

Application

An understanding of changes in automatically detected behaviours in neonatal calf diarrhoea (NCD) and concurrent dehydration allows the development of automatic disease detection tools. Early detection of neonatal calf diarrhoea and concurrent dehydration will improve calf outcomes.

Introduction

NCD is a frequent disease in young calves, which can lead to dehydration. Both conditions are a welfare and production concern. The objective of this study was to identify changes in activity and feeding variables that are associated to NCD, with or without dehydration.

Materials and methods

One hundred and forty-one calves were moved into group-housing at approximately seven days of age, at which point they entered the trial. The calves were then followed until 25 days of age or three days after the development of NCD. Calves were health scored daily as follows: Wisconsin health score (McGuirk, 2008) for respiratory disease, faecal consistency (Faeces, Table 1), hind leg tail and perineum cleanliness (CLEAN, Table 1) and skin tent elasticity. Calves with a faeces score of two or above were classified as having NCD. Calves that had a return of the skin tent in less than three seconds were classified as NCD-Hydrated (NCD-H). Those with a delayed return of the skin tent were classified as NCD-Dehydrated (NCD-D). To remove any effect of bovine respiratory disease, all calves that had a Wisconsin health score that was classified as diseased (>4) had that day and three days either side removed from the dataset. Rectal temperature (recorded daily as part of the Wisconsin Score) was converted to a four-level categorial variable (Temperature, Table 1).

Table 1
The criteria for the tail, perineum and hindleg cleanliness, faeces and temperature scores.

	Scoring criteria		
Score	**CLEAN**	**Faeces**	**Temperature**
0	Clean calf or with a small amount of dried faeces on tail/perineum/hind legs	Formed faeces	37.9–38.3°C
1	A large amount of dried faeces or some pasty faeces on tail/perineum/hind legs	Pasty faeces	38.4–38.8°C
2	Wet Faeces on tail/perineum/hind legs	Loose faeces that did not sift through bedding	38.9–39.4°C
3	A very wet tail/perineum or a large amount of faeces on tail/perineum/hind legs	Liquid faeces that sifted through the bedding	≥39.5°C

Milk feeding behaviours were measured using automatic milk feeders (*Biocontrol*). Calves had access to 7 L of acidified milk replacer daily. Activity variables were measured using a triaxial accelerometer (*IceQube*) attached to the left hind leg. The behaviours measured for each calf were; total time at milk feeder, total milk visits, mean milk visit length, mean milk drinking speed, volume of milk drunk each day, mean milk per visit, daily lying time, daily standing time, daily lying bouts, daily standing bouts, total daily motion index, mean lying bout length, mean standing bout length and mean motion index per standing bout.
General linear mixed modelling was carried out using the lme4 library in R studio (Bates *et al.*, 2015). Disease status, season, sex, sire breed type, temperature score, age and the interactions between disease status and age, disease status and season, and disease status and temperature score were tested as fixed effects. Backwards model selection by AIC was carried out using the step() procedure in R. The calf number nested within pen was included in all models as a random effect.

Results

There were 1125 healthy, 232 NCD-H and 8 NCD-D days for the lying behaviours and 961 healthy, 249 NCD-H and 8 NCD-D days for the milk feeding behaviours available for analysis. Of the fourteen behaviours analysed, seven had residuals that were not normally distributed, despite attempting transformations. The outputs of the final mixed models whose residuals were normally distributed are summarised for the activity and milk feeding behaviours in Tables 2 and 3 respectively.

Table 2
The effect of neonatal calf diarrhoea with or without dehydration on activity behaviours of young pre-weaned artificially reared calves[1]. Factors with $p<0.05$ are shown in bold.

Behaviour	Fixed effect	Level	Effect size	Confidence interval	P value
Daily lying bouts (n)	Disease status	Healthy	Reference	Reference	Reference
		NCD-H	**−1.100**	**−1.245–1.060**	**<0.001**
		NCD-D	−1.180	−1.396–1.000	0.052
	Sire breed type	Beef	Reference	Reference	Reference
		Dairy	**−1.097**	**−0.852 – −0.975**	**0.009**
	Season	Autumn	Reference	Reference	Reference
		Winter	**−1.208**	**−0.780 – −1.144**	**<0.001**
		Spring	**−1.118**	**−1.187 – −1.054**	**0.005**
Daily standing bouts (n)	Disease status	Healthy	Reference	Reference	Reference
		NCD-H	**−1.100**	**−1.141–1.060**	**<0.001**
		NCD-D	**−1.183**	**−1.399–1.000**	**0.048**
	Sire breed type	Beef	Reference	Reference	Reference
		Dairy	**−1.099**	**−0.851 – −0.973**	**<0.001**
	Season	Autumn	Reference	Reference	Reference
		Winter	**−1.210**	**−0.779 – −1.147**	**<0.001**
		Spring	**−1.118**	**−1.186 – −1.054**	**0.004**
Mean lying bout length (minutes)	Disease status	Healthy	Reference	Reference	Reference
		NCD-H	**1.094**	**1.051–1.139**	**<0.001**
		NCD-D	**1.219**	**1.015–1.464**	**0.034**
	Sire breed type	Beef	Reference	Reference	Reference
		Dairy	**1.086**	**1.010–1.167**	**0.027**
	Season	Autumn	Reference	Reference	Reference
		Winter	**1.227**	**1.150–1.308**	**<0.001**
		Spring	**1.095**	**1.026–1.169**	**0.020**
Total daily activity	Disease status	Healthy	Reference	Reference	Reference
		NCD-H	**−132.342**	**−201.323–−77.956**	**<0.001**
		NCD-D	**−346.630**	**−852.797–−67.007**	**<0.001**
	Sex	Female	Reference	Reference	Reference
		Male	**−17.364**	**−58.99 – −0.487**	**0.021**
	Season	Autumn	Reference	Reference	Reference
		Winter	**−65.545**	**−152.157–−15.029**	**<0.001**
		Spring	21.132	−86.220–0.016	0.074
	Disease status x Season				**<0.001**
Mean activity per standing bout	Disease status	Healthy	Reference	Reference	Reference
		NCD-H	**1.233**	**−2.519 – −0.407**	**<0.001**
		NCD-D	**10.093**	**−28.490–−1.086**	**0.004**
	Sire breed type	Beef	Reference	Reference	Reference
		Dairy	**1.018**	**0.020–3.439**	**0.022**

[1] The results shown for the models where a transformation was used have been back transformed.

Table 3
The effect of neonatal calf diarrhoea with or without dehydration on milk feeding behaviours of young pre-weaned artificially reared calves[1]. Factors with $p<0.05$ are shown in bold.

Behaviour	Fixed effect	Level	Effect size	Confidence interval	P value
Total milk visits (n)	Disease status	Healthy	Reference	Reference	Reference
		NCD-H	**0.079**	**0.000–0.293**	**0.037**
		NCD-D	0.055	−0.880–1.999	0.697
	Age		**0.002**	**0.002–0.003**	**<0.001**
	Season	Autumn	Reference	Reference	Reference
		Winter	**0.004**	**−0.118 – −0.008**	**0.001**
		Spring	0.048	0.044–0.006	0.379
	Disease status x Season				**0.005**
	Disease status x Age				**<0.001**
Mean milk visit length (minutes)	Disease status	Healthy	Reference	Reference	Reference
		NCD-H	**1.207**	**1.143–1.025**	**<0.001**
		NCD-D	**1.674**	**1.350–2.079**	**<0.001**
	Age		**−0.977**	**−0.969 – −0.977**	**<0.001**
	Season	Autumn	Reference	Reference	Reference
		Winter	−0.963	−0.932–1.152	0.516
		Spring	−0.914	−1.253–1.046	0.201
	Disease status x Season				**0.044**

[1] The results shown for the models where a transformation was used have been back transformed.

Conclusion
Calves with NCD-H have fewer standing and lying bouts, longer lying bouts, are less active, visit the milk machine more often and have longer visits to milk when compared to their healthy counterparts. Similar results were seen for calves with NCD-D, however dehydration did not have a statistically significant impact on total milk visits and daily lying bouts, most likely due to the small number of NCD-D days. The interaction between disease status and season may reflect a differing response to environmental conditions depending on disease status. The interaction between disease status and age in the number of visits to milk may reflect a differing response to disease as calves grow. The association of NCD-H and NCD-D with changes in behaviour suggests that there is potential for these behaviours to be used in automatic disease detection tools, however factors such as age and season must also be considered.

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54. Interaction between colostrum and milk replacer supply on growth and gastrointestinal development of dairy surplus calves

J. Echeverry Munera [a,b,c], S. Marti [c], M. Steele [b], M. Devant [c], J. Martin-Tereso [a], L. Leal [a]

[a] Trouw Nutrition, P.O. Box 299, 3800 AG, Amersfoort, The Netherlands
[b] University of Guelph, Department of Animal Bioscience, Guelph, ON, Canada, Canada
[c] Institut de Recerca © Tecnologies Agroalimentàries (IRTA), Torre Marimon, Caldes de Montbui, Spain

Presenting author.
Juanita Echeverry Munera. jechever@uoguelph.ca

Application
Morbidity, mortality, and irresponsible use of antimicrobials are common concerns in the rearing of dairy surplus calves. Consequently, there is a pressing necessity to identify mechanisms to motivate dairy farmers to improve calf care. The findings of this study will contribute to the recognition of developmental and nutritional factors influencing surplus calf well-being. This, in turn, will enable producers to implement effective and practical feeding strategies that prioritize animal welfare, enhance overall health, and promote future profitability.

Introduction
In calves, early postnatal nutrient supply influences growth, future health and performance, and gastrointestinal tract (**GIT**) development (Khan et al., 2007; Ollivett et al., 2012). Colostrum management has been identified to be crucial for calf health and survival. Nevertheless, colostrum has been reported to influence GIT development and digestive and absorptive capacities in neonates (Blättler et al., 2001). However, and to our knowledge, the interaction between colostrum and plane of nutrition and their cumulative effects has not been documented before. Therefore, this study examined the interactions between these two critical early-life interventions and their impact on growth performance and GIT development over time in surplus bull calves as they develop in time.