Foal rotavirus – can we learn anything from calf scour?

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The report by Dugdale (p 233) on rotavirus diarrhoea in Thoroughbred foals joins a series of studies which are forcing the realisation that rotavirus is the most common cause of diarrhoea outbreaks in foals. In this, horses are no different from other mammalian species: notably children in which rotavirus is the major cause of severe gastroenteritis and is responsible for approximately 1 million deaths annually (Kapikian and Chanock 1990), and calves in which rotavirus is the single most important infectious cause of the complex syndrome of calf scour (Reynolds et al. 1986).

This article looks at comparative aspects of rotaviral diarrhoea in foals and calves. The comparison is instructive because much has been learnt about rotavirus diarrhoea in calves in the 20 years since its first description.

AETIOLOGY OF NEONATAL DIARRHOEA

Diarrhoea in young calves is certainly more common and perhaps more complex in aetiology than foal diarrhoea. Although an almost bewildering variety of infectious agents has been reported as causing diarrhoea in calves, few agents have been shown to do so commonly. A convenient rule of thumb is that 5 micro-organisms are both common and proven enteropathogens in neonatal calf diarrhoea: 2 viruses, rotavirus and coronavirus; the protozoan Cryptosporidium; Salmonella spp.; and enterotoxogenic strains of Escherichia coli (ETEC). In addition, mixed infections are common.

It is possible that the aetiology of foal diarrhoea is less complex: in a recent comprehensive survey in UK and Ireland only rotavirus and Aeromonas hydrophila were significantly associated with diarrhoea (Browning et al. 1991a), but there is no supporting information to confirm the role of Aeromonas as an enteropathogen.

In addition, salmonellosis is undoubtedly a cause of sporadic cases of foal diarrhoea. However, no equine coronavirus has ever been conclusively identified; cryptosporidiosis was detected equally commonly in diarrhoeic and healthy foals; and there is limited knowledge of ETEC features such as fimbrial adhesins or enterotoxins that are specific for horse gut.

Proven and common enteropathogens in foal diarrhoea are therefore limited to rotavirus and Salmonella. However, it would be prudent to accept the possibility that other enteropathogens may be involved in the significant proportion of undiagnosed cases.

EPIDEMIOLOGY

There are several important features of rotavirus epidemiology:

- Rotaviruses are enzootic, to the extent that infections are normal and frequent not only in young animals but throughout life
- Faeces from diarrhoeic animals can contain more than 1 x 10⁶ infectious doses per gram and, additionally, rotaviruses are both stable in the environment and resistant to some disinfectants – hence exposure early in life can be anticipated
- Faecal-oral transmission takes place readily
- Equine rotaviruses have distinctive characteristics and infection of foals from other mammals either does not therefore occur or is uncommon

It follows that infection of the young animal is frequently subclinical and diverse factors influence this balance between host and pathogen. This accounts for the many environmental influences such as hygiene, crowding, stress and nutrition which are clearly linked with diarrhoea problems.

In calves, the most important external influence is usually a contaminated environment allowing an overwhelming infection that tips the balance from subclinical to overt disease. Dairy calves can be kept clean sufficiently to minimise environmental contamination and control any rotavirus problem – in a large herd this requires a high standard of management and usually considerable capital investment. The most desirable feature from a disease control viewpoint is the complete absence of calf to calf contact, which may be achieved by use of individual hutches.

Suckled beef calves, on the other hand, present a more difficult managerial problem. The environment of such
calves is usually grossly contaminated, the only notable exception being calves born at grass in summer. However, there are commonly economic factors which dictate an autumn–winter–spring calving pattern. All farmers therefore take steps to reduce faecal build up, but under practicable conditions this can be minimised but not eliminated.

Diarrhoea is therefore a common and severe problem, particularly towards the end of the calving period when the enzootic pathogens have been cycling through the early-born calves. Cows and calves housed on slats or straw are difficult to keep sufficiently clean. Animals kept outside, even under extensive conditions, often contaminate feeding or shelter areas which are heavily frequented.

Foals on stud farms face some of the same hazards as calves, but hygienic and economic factors should greatly favour reduced exposure to rotavirus. That rotavirus is ever-present in the foal's environment is exemplified by the common occurrence of severe rotavirus diarrhoea in very young foals which have received inadequate colostrum. Foals kept with their dams separate from all other foals usually remain free of rotavirus problems. However, it is common practice to graze young foals, at least in daytime in a nursery paddock, and then move them on when older. This offers potential for a build up of faecal contamination in the nursery paddock and would not be regarded as sound management by cattle farmers. A calf group is retained in one field and calves born subsequently from separate groups are kept independently, thereby obviating pathogen passage through a succession of susceptible neonates.

CONTROL

The wide importance of rotavirus has led to considerable study of immunity and immunisation, from which much of relevance to horses can be gleaned. Because rotaviruses are enzootic in all populations, virtually all dams transfer antibody to their offspring. There are important differences both within the ungulate species and between the ungulates and man in the mechanisms of transfer.

Human infants acquire the major part of the transferred antibodies in utero, whereas ungulates are effectively born agammaglobulinaemic. Cow colostrum contains antibodies which are predominantly IgG1 and are acquired from the circulation and ruminant milk contains only low concentrations of IgG1. IgA predominates in mare colostrum and significant concentrations of IgA produced in the mammary gland continue to be secreted in post-colostral milk.

Traditional emphasis has been placed on the importance of early colostral feeding and immunoglobulin absorption to ensure neonatal viability. However, there is good evidence that such absorbed antibodies in circulation offer relatively poor protection against rotavirus infection, in which there is no viraemic phase and infection is confined to gut enterocytes.

On the other hand, the continued presence of antibodies in the intestinal lumen is an effective prophylactic for rotavirus. The distinct immunoglobulin profiles of cows' and mares' lacteal secretions therefore offer the young foal a clear advantage.

Cow colostrum under natural conditions contains rotavirus antibodies and provides local protection to the intestine for the first 3–4 days of post-uterine life only. This is consistent with the virtual absence of rotavirus diarrhoea in calves in the first few days post partum and the marked peak in prevalence in the 2nd and 3rd weeks.

Because both colostrum and milk of the mare contain significant IgA antiviral titres for several weeks after foaling the natural protection afforded to the foal's intestine is greater. Again, this is illustrated by the lack of a clear peak age of prevalence, with disease occurring sporadically up to several months of age.

Active immunisation. Although live attenuated rotavirus vaccines were developed 20 years ago for calves, the general failure of such vaccines is probably due to the early neutralisation of vaccine virus by ingested colostral antibody. Major efforts to develop similar vaccines for children have revealed the additional problem that immunity conferred by such vaccines is strain-specific. Although it is not impossible that live oral vaccines will be developed for foals, it currently seems less probable.

Passive immunisation. Rotavirus vaccination of pregnant cows, which stimulates increased titres of specific IgG1 in both colostrum and post colostral milk, has led to several successful and effective commercial vaccines. An additional and originally unforeseen advantage has been the heterotypic nature of the cows' antibody response, which has proved cross-protective for most rotavirus strains.

The potential of a similar product for the vaccination of mares has been demonstrated (Browning et al. 1991b), used both in pregnancy to stimulate IgA early in lactation and several weeks after foaling to provide protection to the older sucking foal. However, the current formulations of the bovine rotavirus vaccines rely on water-in-oil emulsions as adjuvants, which can on occasion produce unacceptable local reactions in mares. Reformulation and re-registration of less reactogenic rotavirus vaccines specifically for mares may be viewed as uneconomic by commercial manufacturers.

Passive protection by feeding. In the absence of an acceptable vaccine, the logic of feeding immunoglobulins to provide continued local gut protection is persuasive. The feasibility of this approach has been amply demonstrated in children at high risk of nosocomial infection (Barnes et al. 1982). Again it is probable that economic factors will dictate whether such a product suitable for foals will be marketed. Alternative sources are mare plasma as used in Dugdale's study, or plasma from...
old mares vaccinated with bovine rotavirus vaccine. Colostrum from vaccinated cows generally provides the highest available titre of antibodies to both bovine and equine rotaviruses.

CONCLUSIONS

The most instructive parallels with non-equine species are:

- Epidemiology - economic circumstances dictate that foals are generally maintained in a less contaminated environment than calves and hence the prevalence of rotavirus diarrhoea is lower. However, rotavirus is the major cause of severe gastroenteritis in human infants in the industrialised as well as the developing countries and good hygiene alone cannot therefore solve the problem.
- Control through vaccination - the studies on oral immunisation of children and passive immunisation by vaccinating cows and mares have shown the technical feasibility of developing equine rotavirus vaccines.
- Treatment - the universal use of oral rehydration therapy for diarrhoea and dehydration in children and calves has saved countless lives and it remains the main plank of therapy in foals also.

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