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DEVELOPMENT OF CALF DIARRHŒA VACCINES

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Abstract

Rotavirus and enterotoxigenic *E. coli* were found to cause approximately threequarters of the total number of outbreaks of diarrhoea in young calves. Vaccinating pregnant cows with a combined vaccine of K99 antigen from *E. coli* and inactivated calf rotavirus stimulated secretion of specific antibodies in colostrum and milk. Calves born to vaccinated cows were completely protected against experimental enterotoxigenic colibacillosis. The efficacy of the rotavirus component is being investigated in field trials from which the early results look promising.

The results to date of an ongoing survey of the aetiology of calf diarrhoea outbreaks in Scotland and the north of England are shown in table 1.

These results are based on the excretion of the particular microorganism by more than one-third of the diarrhoeic calves on each farm, and on a significant difference in excretion rates between diarrhoeic and normal calves for all these enteropathogens.

This background data provides the rationale for our attempt to develop a rotavirus/ETEC vaccine, in that an effective rotavirus/ETEC vaccine could be expected to be of benefit in 20 of the 26 outbreaks investigated (77 %) in which rotavirus and ETEC were shown to be involved. Other surveys also confirm the importance of rotavirus and ETEC infections in other countries (Moon *et al.*, 1978; Morin *et al.*, 1976; de Leeuw *et al.*, 1980a).

Our approach has been based on passive immunisation of the calf by vaccinating the pregnant cow. Antibodies ingested by the young calf and subsequently present in the gut lumen appear to be more effective at preventing enteric infections

than circulating antibodies (Snodgrass and Wells, 1978).

In strains of *E. coli* isolated in the U.K. there is complete correlation between enterotoxigenicity as measured by dilation of ligated calf gut loops and production of K99 pili and enterotoxin STa (Sherwood *et al.*, 1983). Thus selection of K99 as an immunogen for ETEC seems logical. The effect of combined rotavirus/K99 vaccination of pregnant cows on subsequent ETEC challenge of their calves is given in table 2 (Snodgrass *et al.*, 1982).

There seems general agreement that such ETEC vaccines are effective at preventing enterotoxigenic colibacillosis (Acrez *et al.*, 1979; Myers, 1980; Contrepois *et al.*, 1982). As the disease occurs almost exclusively in calves 1-2 days old (Moon *et al.*, 1978) specific antibodies in colostrum are sufficient to confer protection.

The history of rotavirus vaccines is much more controversial. Despite the early cultivation and attenuation of a strain of calf rotavirus (Mebus *et al.*, 1973), the efficacy of the live rotavirus vaccine in either the pregnant cow or the neonatal calf is

Table 1. — Aetiology of calf diarrhoea outbreaks in Scotland and Northern England

rotavirus	10 farms
ETEC (enterotoxigenic <i>E. coli</i>)	3 farms
cryptosporidium	1 farm
rotavirus + cryptosporidium	3 farms
rotavirus + coronavirus	3 farms
rotavirus + coronavirus + cryptosporidium	1 farm
unknown	5 farms

Table 2. — Clinical results of ETEC challenge.

Vaccine group	No. of calves with diarrhoea/no. in group	wt. at 48 h/ wt. at birth (%)	Minimum faecal dry matter (%)
Control	5/6	94.3	8.4
Vaccine	0/18	105.8	25.4

Table 3. — Rotavirus vaccine on dairy farm 1.

	Controls	Vaccinates
No. with diarrhoea/ no. in group	16/21	4/10
Duration of diarrhoea (days)	2.3	0.5*
Faecal index	50.7	28.6*
Liveweight gain (g/day)	110	270*

*: $P < 0.05$.

Table 4. — Rotavirus/K99 vaccine on dairy farm 2.

	Controls	Vaccinates
No. with diarrhoea/ no. in group	6/7	2/11*

*: $P < 0.05$.

Table 5. — Rotavirus/K99 vaccine on beef suckler farm 3.

	Controls	Vaccinates
No. with diarrhoea/no. in group	26/35	24/32
Age at onset (days)	6.6	8.2*
Rotavirus diarrhoea/no. with diarrhoea	16/26	8/24*
<i>Cryptosporidium</i> sp. diarrhoea/no. with diarrhoea	4/26	12/24*

*: $P < 0.05$.

widely questioned (de Leeuw *et al.*, 1980b; Acres and Radostits, 1976).

However, the use of inactivated rotavirus vaccines in adjuvant to immunise pregnant cows has achieved apparently greater success (Navetat,

1982; Van Opdenbosch and Wellemans, 1982; Snodgrass *et al.*, 1980). After parturition, high rotavirus antibody titres are secreted in colostrum and milk for several weeks.

Experimental evidence for the efficacy of these

vaccines is lacking, although field trial data are promising (tables 3, 4 and 5).

An effective rotavirus/ETEC vaccine would be of great benefit to calf-rearing. Coupled with improvements in management, it could be expected to lead to a substantial reduction in morbidity and mortality due to diarrhoea. However, infections such as *Cryptosporidium* sp and coronavirus would continue, although the economic impact of these

in the absence of rotavirus may be lessened. Future modifications to a calf diarrhoea vaccine could include incorporation of coronavirus, and serotypes of calf rotavirus if significant.

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Question

From Dr Logan to Dr Snodgrass.

Enteropathogenic *E. coli* are present in the environment of calves. If there is no antibody against K99 in colostrum, how do calves survive?

Answer

Enteropathogenic *E. coli* are exotic infections on the British Mainland. They are not present in herds.