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Outbreaks of bovine salmonellosis caused by serotypes other than *S. dublin* and *S. typhimurium*

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SUMMARY

Outbreaks of salmonellosis caused by serotypes other than *S. dublin* and *S. typhimurium* were investigated on 41 farms in north-west England. Of these, 37 (90%) were in dairy cows. There was strong circumstantial evidence that contaminated dairy cake was the source of infection in at least four herds and probably many more. Twenty-six serotypes were encountered with *S. newport*, the commonest, causing the most severe disease. Most cattle seemed to rid themselves of infection during the following months whether or not they were at pasture, housed in cubicles or in byres. Some cows excreted salmonellas for up to 11 months after the disease outbreak. Associated human salmonellosis was confirmed on 3/41 (7%) of the farms.

INTRODUCTION

The commonest salmonella serotype found in British cattle is *Salmonella dublin* (Sojka & Field, 1970). *Salmonella typhimurium* is less common and the remaining members of the genus, referred to in this paper as 'other' serotypes, have been relatively rare until recently.

In 1973 this situation changed as is shown by the number of salmonella incidents reported by veterinary laboratories in England and Wales (Table 1). *S. dublin* incidents have apparently declined, while those associated with *S. typhimurium* and other serotypes have increased both relatively and absolutely.

This paper records investigations made after incidents of salmonellosis in cattle where 'other' serotypes were isolated, in north-west England in 1973. Information was collected to determine the clinical and epidemiological features of the outbreaks, especially the persistence of faecal excretion. An attempt was made to assess the probable origins of the salmonellas and to determine the possible effects of different systems of husbandry on the duration of excretion.

MATERIALS AND METHODS

Pathological material from farms in Cumbria and adjacent parts of north Lancashire is normally submitted by practising veterinary surgeons to Penrith Veterinary Investigation Centre (VIC). Two veterinary practices which submitted

Table 1. *Bovine salmonella incidents in England and Wales*

(Percentages in parentheses.)

Year	*S. dublin*	*S. typhimurium*	Other serotypes	Total
1964	692 (73)	230 (24)	25 (3)	947
1965	960 (56)	720 (42)	34 (2)	1714
1966	1137 (73)	388 (25)	31 (2)	1556
1967	1539 (81)	332 (18)	20 (1)	1891
1968	1970 (79)	511 (20)	27 (1)	2508
1969	4012 (89)	415 (9)	71 (2)	4498
1970	3056 (86)	426 (12)	85 (2)	3567
1971	2074 (83)	337 (14)	77 (3)	2488
1972	1684 (71)	588 (25)	84 (4)	2356
1973	1429 (54)	802 (31)	388 (15)	2619

1964–7, Sojka & Field (1970); 1968–73 W. J. Sojka (1974, personal communication).

specimens to this laboratory also sent some to Liverpool VIC and those herds were included in the investigations.

At Penrith VIC rectal swabs and faeces samples from cattle were routinely cultured in selenite F broth (Oxoid) from which subcultures on plates of deoxycholate citrate lactose sucrose agar (DCLS), Oxoid CM393, were made after 24 and 48 hr. incubation at 37° C. At Liverpool VIC specimens were cultured in selenite F broth at 43° C. and subcultures made on MacConkey agar plates after 24, 48 and 96 hr. incubation. At both laboratories, suspect colonies were identified by slide agglutination and submitted to the Central Veterinary Laboratory, Weybridge and the Salmonella Reference Laboratory, Colindale for confirmation.

Between 18 February and 22 April 1974 all the cows in most of the herds were swabbed using calcium alginate rectal swabs (Medical Wire Co., Corsham, Wilts.) to discover whether faecal excretion still occurred after a period of housing. The rectal swabs were cultured at the Public Health Laboratory, Preston, using selenite and tetrathionate broths as enrichment media with subcultures on Wilson and Blair's agar medium after 24 and 48 hr. incubation at 37° C. Suspect salmonella colonies were treated as outlined above.

Ten samples of faeces were taken from the floors of the cubicles of loose-housed herds; 10 g. from each sample was cultured in selenite F broth and subcultured on DCLS plates after 48 hr. incubation at 37° C.

Visits were made to most of those herds which had suffered bovine salmonellosis to obtain information on the severity of the disease, and the husbandry and feeding of the cattle both at the time of the outbreak and subsequently.

RESULTS

From a total of 45 herds in Cumbria and North Lancashire which had suffered bovine salmonellosis in 1973, 41 (91 %) were visited and 36 (80 %) were later examined by means of rectal swabs. Of these herds 40/41 (97 %) were dairy herds (see Table 2) and in 37 (90 %) adults were initially affected. Calves only in three dairy herds were affected (*S. havana, S. anatum, S. othmarschen*). The single

Table 2. *'Other' serotypes in cattle, north-west England,* 1973

	Dairy herds		
	Adults	Calves only	Beef herd
S. amsterdam	1	—	—
S. anatum	2	1	—
S. anatum (*S. telaviv*)	2	—	—
S. amager (*S. westhampton*)	1	—	—
S. bareilly	1	—	—
S. bovismorbificans (*S. infantis*)	1	—	—
S. corvallis	1	—	1
S. ealing	1	—	—
S. enteritidis	2	—	—
S. fresno	2	—	—
S. hato (*S. emek*)	1	—	—
S. havana	—	1	—
S. kidderminster	1	—	—
S. kitenge	1	—	—
S. mons	1	—	—
S. newport	14	—	—
S. newport (*S. cubana*)	1	—	—
S. oranienburg	2	—	—
S. othmarschen	—	1	—
S. tennessee	1	—	—
S. virchow	1	—	—
Total herds	37	3	1

Serotypes in parentheses isolated after the initial outbreak.

beef herd incident was associated with *S. corvallis* which was isolated from an aborted fetus.

Origin of salmonellas

There was circumstantial evidence to incriminate dairy cake fed to milk cows as the vehicle of infection on at least 10 farms. This conclusion was reached independently at VIC, Penrith and VIC, Liverpool.

'Other' salmonellas were isolated only twice from bovine specimens at Penrith VIC in 1971 and again in 1972 but between mid-April and mid-May 1973, *S. newport*, *S. bovismorbificans*, *S. virchow*, *S. anatum* and *S. fresno* were isolated from sick cattle on eight farms in South Cumbria. Inquiries into the first outbreak (Farm 5) revealed that the disease occurred immediately after the bulk delivery of dairy cake from a merchant (A). The other seven herds were found to have received A's dairy cake at roughly the same time. Histories from four herds, two of which were included in the first eight, support the view that dairy cake was responsible for the disease.

Case histories

Farm 5. Eighty cows were tied indoors at the time of the outbreak. Forty (50%) of these cows suffered enteritis as did 17/26 (65%) of young stock also given

merchant A's dairy cake. Dry cows standing in the byre not given the dairy cake were not ill. *S. newport* was isolated from sick animals.

Farm 7. This was a small dairy farm situated in hill country with no stock other than hill sheep in the vicinity and 5/25 (20%) cows were ill while tied indoors. Cows were fed merchant A's dairy cake. *S. newport* was isolated from sick cows.

Farm 35. This herd was at grass and received a bulk delivery of merchant A's dairy cake every three weeks. After a batch had been received in July, 80/132 (60%) of the cows were ill. *S. newport* was isolated from rectal swabs. The next batch of cake was of different origin but was placed in the same hopper. Illness in the dairy cows ceased for three weeks until the almost empty bin was swept out and the residue of merchant A's cake, which was of a different colour, was swept down into the hoppers for consumption. Enteritis immediately started again.

Farm 47. Merchant A's cake was fed to cattle in July, and 11/30 (36%) cows were ill with *S. newport* infection. Ten dry cows not given the cake were not ill but the bull and 1/11 (9%) heifers which were given the cake suffered enteritis. Five cows steaming up on another brand of cake were not ill.

Thirty (73%) of the 41 affected herds were fed on merchant A's cake and 26 (63%) were located within 20 miles of his premises in an area where he had a large share of the market.

S. phoenix and *S. montevideo* were isolated from cake in unopened bags on Farm 7. *S. liverpool* was isolated from merchant A's cake in a bulk hopper on Farm 48, where *S. anatum* and *S. telaviv* was diagnosed in cattle (VIC, Liverpool).

Clinical disease

In most cases the outbreak was of short duration (under two weeks) but occasionally further cases occurred in the following weeks. Of 1812 adult cows at risk on the 37 dairy farms, 414 (22%) suffered disease but only 4 (0·9%) of the 414 sick cows died (Table 3). Milk yields were severely reduced during the course of the illness and many cows lost a great deal of weight. Production throughout the lactation was reduced and in many herds this caused considerable financial loss.

Nineteen serotypes were isolated from the 37 dairy herds but in six herds other serotypes were isolated after the initial outbreak and where referred to have been included in parentheses (Table 2). Of the 37 herds investigated, *S. newport* was isolated from 15 (40%) and *S. anatum* from 4 (11%), although in two herds it was also associated with *S. telaviv*. In some herds salmonellosis apparently spread to young stock. On three separate farms isolations were made from scouring calves without evidence of salmonellosis in the adults.

There was considerable variation in the percentage of animals suffering disease in any given herd, from 1% to 60% (Table 4). Table 3 illustrates the mean percentage incidence in two groups of herds. Group 1 consists of 15 dairy herds from which *S. newport* was first isolated (*S. cubana* was later isolated from 1 herd); 2 herds from which *S. anatum* was isolated and 2 herds with mixed *S. anatum*

Table 3. *The incidence of clinical disease*

Serotype	Cattle at risk	Clinical infections	%
S. anatum *S. anatum* (*S. telaviv*) *S. newport* *S. newport* (*S. cubana*)	944	360	38·1
Remaining serotypes	868	54	6·2
Total	1812	414	22·8
Deaths		4	0·9

and *S. telaviv* infections. Group 2 comprised the remaining 18 dairy herds from which 15 serotypes were isolated initially (Table 2). In Group 1 the mean percentage incidence (MPI) of illness was 38·1 %; in Group 2, 6·2 %. There was no significant difference in Group 1 between the incidence of *S. newport* and *S. anatum* infections, but the difference between the MPIs in Groups 1 and 2 is highly significant ($P < 0{\cdot}001$).

Faecal excretion of salmonellas by grazing cattle following disease outbreak

The veterinary surgeons attending 7 dairy herds (Herds 5, 7, 8, 9, 6, 18, 27) swabbed all milk cows at varying times after the initial diagnosis while they were still at pasture. The numbers of cattle excreting salmonellas declined at varying rates which were not apparently related to the serotype involved. Two herds infected with *S. newport* (5, 7) and one with *S. bovismorbificans* and *S. infantis* (8) ceased to excrete salmonellas while still at pasture. In two herds some animals were still excreting after four months of housing, herd 9 with *S. newport* (*S. cubana*) and herd 27 with *S. kidderminster*, and in herd 6 (*S. anatum* and *S. telaviv*) salmonella excretion by some animals persisted for four months. In the case of herd 18 (*S. amager* and *S. westhampton*) it was not known how long faecal excretion persisted.

Faecal excretion of salmonellas by cattle after housing

The period between the disease outbreak and the examination of the housed herds varied from 2 to 10 months and that elapsing between housing and the examination varied from 10 to 26 weeks. Nineteen (1 %) of the 1825 cows yielded salmonellas when examined in February and March 1974. These isolations could not be related to the time elapsing between the disease outbreak and the examination or to the duration of housing. There was little difference between the percentage of isolations from the tied and loose housed herds, 0·8 % and 1·2 % respectively (Table 4). Salmonellas were not isolated from any of the floor samples from the cubicles.

Illness in humans

Six out of 41 farmers (14 %) reported vomiting or diarrhoea or both in members of their staff or family at the time of the disease outbreak in cattle. In three

Table 4. *The duration of excretion in 7 herds*

		1973				Feb.–April 1974 – re-examination of infected herds								
			Animals					Animals			Total			
Herd	Serotype	Date of outbreak	Exd	In-fected	%	Months after out-break	Weeks housed	Exd	Ex-creting	Type of housing	Herds	Cattle	Ex-creting	%
11	*fresno*	April	51	5	10	10	17	44	1	Byre				
9	*newport* (*cubana*)	May	23	8	34	9	19	23	1	Byre				
6	*anatum*, *telaviv*	May	30	9	30	10	19	30	2	Byre	23	720	6	0·8
33	*newport*	June	40	24	60	8	26	44	2	Byre				
27	*kidderminster*	Sept.	80	5	6	6	19	73	8	Loose				
30	*anatum*	Oct.*	160	50	31	4	26	123	4	Loose	13	1105	13	1·2
50	*hato*	Nov.*	68	1	1	3	15	59	1	Loose				
											36	1825	19	1·0

* Outbreak occurred when housed.

instances the family doctor confirmed salmonellosis and the serotypes found were the same as those affecting the cattle (*S. newport* in two cases and *S. telaviv* in one).

Contact with pigs and poultry

Pigs were kept on 2 out of the 41 farms (4·8%) and poultry, usually a few yard hens, on 20 (48%).

DISCUSSION

Because of the similarity between the serotypes occurring in pigs and poultry and those found in their feeding stuffs, Report (1965) considered that contaminated feed was of epidemiological significance in those species. There was no such similarity with respect to cattle and the report concluded that cattle feeds were not likely to be commonly responsible for the infection of cattle. There are nevertheless many references in the literature to the occurrence of bovine salmonellosis associated with exotic serotypes. These consist mainly of slaughter-house surveys or descriptions of individual outbreaks with few quantitative data to guide the clinician or epidemiologist in the formulation of a prognosis.

Discovering the source of salmonellas which have infected stock is notoriously difficult; the whole environment is soon contaminated with organisms especially where copious faeces producers like cattle are concerned. Cattle cake which is frequently handled in bulk in close proximity to cows may be contaminated on the farm so that the isolation of salmonellas from it does not necessarily indicate that it was the source of infection. The brief case histories cited provide evidence that infected dairy cake was the vehicle of infection on at least four farms and very likely on a great many more. The first eight cases encountered at VIC, Penrith, support this view and the apparent concentration of outbreaks in the area where merchant A had a large share of the market adds more weight. It is significant that cattle became ill while tied indoors. None of this evidence considered singly constitutes proof but considered together the conclusion is difficult to resist. The dairy cake was cubed and whether it was contaminated after manufacture or compounded from infected materials or both was not known. The only unopened bags which were examined contained *S. phoenix* and *S. montevideo*. It is not usual to identify every colony grown and the isolation of one or two serotypes from a sample does not preclude the presence of others. It was not possible on the other farms to examine the cattle cake immediately after the disease outbreak. There were no grounds for suspecting that the keeping of pigs or poultry was associated with the occurrence of disease.

There was a wide variation in the morbidity associated with all serotypes although mortality was low (0·9% of sick cattle). Mortality in adult cattle suffering from *S. dublin* is much higher (Bythell, 1946; Field, 1948; Barron & Scott, 1949; Clarenburg & Vink, 1949; Osborne, 1952; Gibson, 1958; Richardson & Watson, 1971). *S. newport* was the commonest serotype in this series and the incidence of clinical disease was highest in those cattle which it affected (MPI 39·8%). The cattle with *S. anatum* and mixed infections of *S. newport* (*S. cubana*)

and *S. anatum* (*S. telaviv*) suffered similarly (MPI 35·2%) whereas with the remainder the MPI was 6·2%. This may be due to differences in pathogenicity for cattle of the various serotypes or *S. newport* and *S. anatum* may have been present in greater numbers in the original challenge. Rohr (1962) concluded that the infectivity of salmonellas for cattle was limited and these findings support that view.

Field (1948) showed that grazing contacts of an active carrier of *S. dublin* could also excrete the organism presumably by voiding ingested organisms. Heard, Jennet & Linton (1972) showed that a high percentage of floor samples taken from collecting yards of cows on intensive grazings could yield *S. dublin*. It was not unreasonable to expect that a similar phenomenon might occur with other salmonellas. If this happened immediately after the outbreak it did not last long and a self cure seemed to operate in most cases although some cows remained infected for several months. The fact that some cows continued to excrete salmonellas for up to 4 months when tied indoors with individual water bowls and food troughs suggested that organisms were reproducing in their alimentary canals. Whether such animals may remain infected for life and become permanent carriers is not known. Adult cattle recovered from clinical *S. dublin* disease invariably remain permanent carriers (Field, 1948).

Because salmonella excretion may be intermittent, the results of a single examination cannot be interpreted too strictly. However, the single examination of 36 herds involving 1825 cattle allows a general observation. Richardson & Watson (1971) showed a positive correlation between the occurrence of *S. dublin* disease and the loose housing of dairy cows in Cumberland and bearing in mind the observation of Heard, Jennet & Linton (1972) it seemed likely that infection would persist more readily in loose-housed herds where the concentration of animals would be more dense and contact more close than in those at grass or tied in byres. Some cows remained infected for many months after the disease outbreak but again the general amount of infection fell whether or not the cows were loose-housed. The factors which might account for a particular animal remaining infected were not investigated but such cattle could cause subsequent disease outbreaks.

CONCLUSION

Considering the serotypes normally encountered in cattle, Report (1965) concluded that feedingstuffs were not primarily responsible for bovine salmonellosis but warned that their importance should not be entirely disregarded. This paper suggests that contaminated feedingstuffs gave rise to several bovine salmonella incidents which caused large economic losses. The fact that other salmonellas occurred to a much greater extent throughout England and Wales in 1973 (Table 1) suggests that a common factor was possibly partly responsible. In many cases cattle would become infected from streams polluted by other cattle or by effluent from pig and poultry units or even from human sewage (Bicknell, 1972). The true incidence was probably much higher since many cases would be treated without a laboratory diagnosis. The self-cure of cattle infected with

other serotypes suggests that, provided constant challenge is minimized, they are unlikely to become major reservoirs of infection from which other species, including man, may become infected.

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