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Isolations of salmonellas from human, food and environmental sources in the Manchester area: 1976–1980

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SUMMARY

A retrospective survey was carried out for isolations of salmonellas from humans, foods and sewer swabs from food-handling premises for the period 1976–80.

The predominant serotypes isolated from humans were *S. typhimurium*, *S. hadar*, *S. virchow* and *S. agona*.

Salmonellas were found in less than 1 % of cooked pork and poultry products and were not detected in cooked beef or lamb. The isolation rates for cooked offal and cooked open pet foods were 2·1 % and 19·7 % respectively. Isolation rates for uncooked meats ranged from 5 % for beef to 36 % for poultry. Most of the uncooked meats were sausages in which the predominant serotypes were *S. derby*, *S. typhimurium*, *S. heidelberg* and *S. panama*.

An attempt was made to investigate the relationship between serotypes isolated from humans and from sausages and sewer swabs. *S. typhimurium* and *S. bredeney* were predominant in humans, sausages and sewer swabs whilst *S. derby*, *S. panama* and *S. give* were predominant only in sausages and sewer swabs.

INTRODUCTION

Salmonellas are one of the major causes of food poisoning in England and Wales and were responsible for 75 % of all cases from recognized bacterial causes in 1976–8 (Hepner, 1980). During this period the most common serotype isolated from humans was *S. typhimurium* followed by *S. hadar* and *S. enteritidis*. *S. typhimurium* remained the most common serotype in 1979 and 1980 but was followed by *S. hadar* and *S. virchow* in 1979 (Communicable Disease Surveillance Centre, 1980*a*) and *S. hadar* and *S. anatum* in 1980 (Communicable Disease Surveillance Centre, 1981).

General outbreaks of salmonellosis remained relatively constant from 1970 to 1980 whereas family outbreaks decreased during this period (Communicable Diseases Surveillance Centre, 1980*b*, 1981). Poultry were responsible for 70 % of salmonella outbreaks in 1976–8 (Hepner, 1980).

The present paper presents a retrospective study of data for isolations of salmonellas in the Manchester area for the period 1976–80.

MATERIALS AND METHODS

Specimens

Faecal specimens were submitted by patients with diarrhoeal disease and their contacts and by food handlers and waterworkers. Cultures of salmonella from other hospitals were also submitted to this laboratory for further identification and are included in this study. These were mainly from faecal specimens although details of the source were not always given, and 21 cultures were stated to be from non-faecal sources.

Food specimens were obtained from food manufacturing and retail premises including shops, restaurants and canteens and in connexion with food poisoning investigations. Foods from factories which were to undergo further treatment prior to retail sale were not included as it was considered that these did not constitute a hazard to the public.

Sewer swabs were obtained from meat handling premises such as abattoirs and factories.

The numbers of specimens of foods and sewer swabs analysed are shown in Tables 2 and 3.

Microbiological methods

Faeces specimens were plated onto desoxycholate citrate agar (DCA) (Hynes' modification, Hynes, 1942) and enriched in selenite F broth (peptone 50 g, mannitol 40 g, Na_2HPO_4 100 g or Na_2HPO_4–$12H_2O$ 252·2 g sodium biselenite 40 g, conc. HCl 15 ml, distilled water 10 l.) at 37 °C overnight followed by plating on DCA. The DCA plates were incubated overnight at 37 °C and suspicious colonies examined by serological and biochemical tests.

All food specimens (25–30 g where available) were enriched in 200 ml tetrathionate media based on Rolfe's tetrathionate 'A' broth (Rolfe, 1946) and incubated at 41 °C. Plating was on DCA and on either Brilliant Green Agar (Oxoid) or Brilliant Green MacConkey Agar (Harvey, 1956) after incubation of enrichment cultures at 41 °C for 1 and 2 days. Foods were also enriched in 100 ml selenite F broth at 41 °C plated on selective agars as described above until July 1979, when this method was discontinued owing to a superior isolation rate in tetrathionate broth.

For whole chickens or turkeys a swab was taken of the gut area in addition to samples of flesh in specimens analysed in the latter part of the programme.

Sewer swabs were enriched in 400 ml of either selenite F broth or tetrathionate broth. Dilutions of approximately 1 : 10 and 1 : 100 were made in the same medium. The enrichments were incubated at 41 °C and plated on selective agars as described above.

Serotype identification was carried out initially at the Public Health Laboratory, Manchester. The identity of most of the isolates was confirmed at the Division of Enteric Pathogens, Central Public Health Laboratory, Colindale, London. Phage typing of *S. typhimurium* was also carried out at Colindale.

Epidemiological data

An attempt was made to correlate human isolations with those from foods and sewer swabs. Thus human isolations are expressed as numbers of incidents and not as total cases. Only one salmonella was recorded for each incident unless more than one serotype was implicated when an incident was recorded for each serotype isolated. Three types of incident were recognized as follows.

(1) An isolated individual with no known infected contacts.

(2) An outbreak amongst a family or group of people in which institutional catering was not known to be involved.

(3) An institutional outbreak such as at a hotel or canteen. This includes milkborne outbreaks.

Patients with a record of travel outside the Manchester area were omitted, as an attempt was made to correlate the serotypes of salmonellas isolated from humans with those isolated from foods.

Isolations from foods implicated in food poisoning outbreaks were recorded as one isolation where the same organism was found in a variety of foods associated with the same outbreak. All serotypes were recorded for food specimens where more than one serotype was isolated from the same source.

RESULTS

The 10 most frequently isolated salmonellas from human incidents are shown in Table 1, and isolation rates per annum for seven of these serotypes are shown in Figs 1 and 2. Incidents caused by *S. typhimurium* fluctuated throughout the period and were particularly high in 1980 when a high incidence of diarrhoeal

Table 1. *The predominant salmonella serotypes isolated from human sources, 1976–80*

Serotype	Total incidents*	Family/contact outbreaks	Institutional outbreaks
S. typhimurium	335	67 (20%)	3 (< 3%)
S. hadar	176	36 (20%)	12 (7%)
S. virchow	109	27 (25%)	0 (< 3%)
S. agona	102	27 (26%)	2 (< 3%)
S. heidelberg	80	15 (19%)	1 (< 3%)
S. enteritidis	56	5 (9%)	8 (14%)
S. bredeney	54	6 (11%)	0 (< 3%)
S. stanley	48	18 (38%)	0 (< 3%)
S. indiana	41	12 (29%)	1 (< 3%)
S. saint-paul	31	7 (23%)	0 (< 3%)
Other serotypes	381	58 (15%)	3 (< 3%)
Total	1413	278 (20%)	30 (0·2%)

Figures in parentheses indicate percentages of total incidents.

* Total incidents include isolated individuals with no known contacts, outbreaks amongst a family or group of people in which institutional catering is not known to be involved (Family/contact outbreaks) and institutional outbreaks, e.g. those associated with a hotel or canteen and including milk-borne outbreaks.

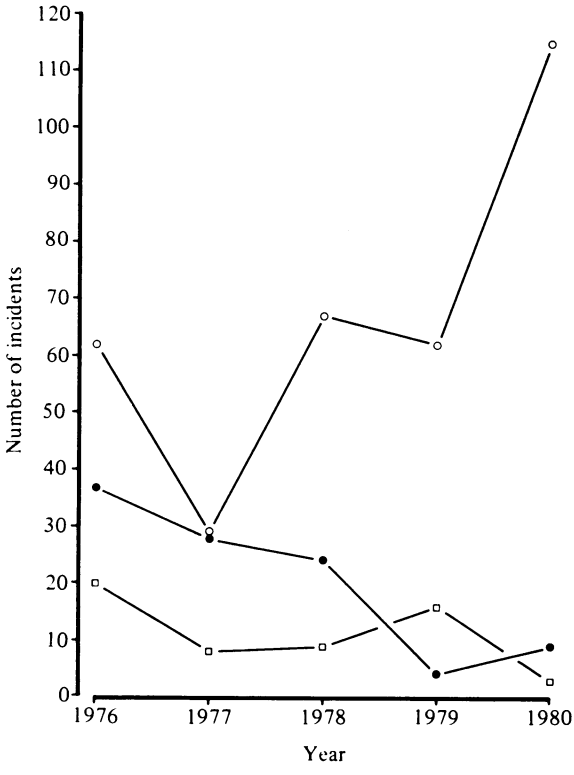

Fig. 1. The numbers of salmonella incidents in humans caused by *S. typhimurium* (○), *S. agona* (●) and *S. enteritidis* (□) from 1976 to 1980.

disease due to phage type 204a was observed (41 incidents). Maximum numbers of incidents were observed in 1979 for *S. hadar*, *S. virchow*, *S. bredeney* and *S. heidelberg*. Two large-scale institutional outbreaks, each affecting over 100 people, were caused by *S. hadar*. One, in 1977, was due to the consumption of contaminated turkey and the other, in 1979, was caused by contaminated ham. Most of the institutional outbreaks were due to *S. hadar* and *S. enteritidis* (Table 1). An outbreak of food poisoning due to *S. typhimurium* phage type 204b was reported in which the organism was isolated from 30 people and from corned beef, ham and tongue which had probably been contaminated during preparation. Two milk-borne outbreaks due to *S. typhimurium* were reported. In one outbreak, phage type 170 was isolated from milk filters, from six patients and from a variety of animals on the farm where the milk was produced. Phage type 74 was implicated in the second outbreak.

Outbreaks amongst families or groups of people in which there was no record of institutional catering accounted for 20 % of total incidents (Table 1). The figure was lower for *S. enteritidis* (9 %) and *S. bredeney* (11 %). The converse was true for *S. stanley* (38 %).

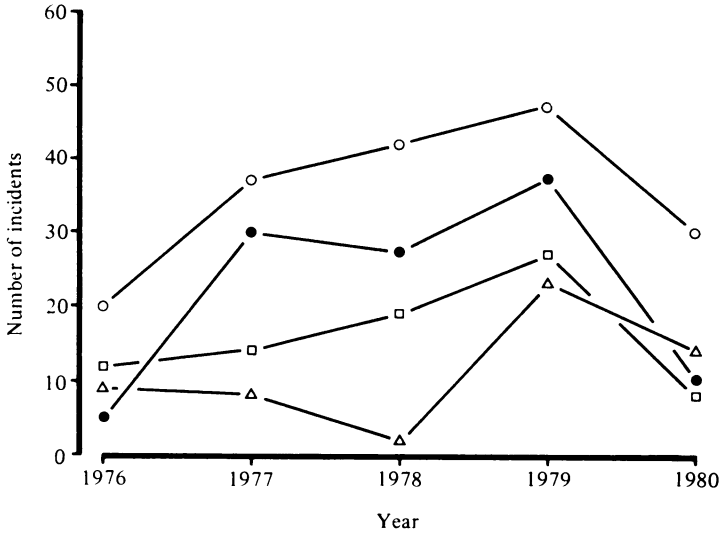

Fig. 2. The numbers of salmonella incidents in humans caused by *S. hadar* (○), *S. virchow* (●), *S. heidelberg* (□) and *S. bredeney* (△) from 1976 to 1980.

Table 2. *Isolations of predominant human salmonellas from raw meats and sewer swabs from meat-handling premises*

Serotype	Poultry	Pork /Bacon	Lamb	Beef	Sausage /sausage meat	Mince*	Sewer swabs
S. typhimurium	3	3	3	3	50	0	24
S. hadar	3	0	0	3	3	1	4
S. virchow	2	0	0	2	2	0	6
S. agona	0	1	0	2	7	2	13
S. heidelberg	0	0	0	3	18	0	11
S. enteritidis	2	0	0	0	0	0	0
S. bredeney	10	0	5	2	12	1	16
S. stanley	0	0	0	0	7	0	25
S. indiana	6	0	0	0	4	0	0
S. saint-paul	0	0	0	0	2	0	1
Other serotypes	6	6	2	8	194	4	183
Total	32	10	10	23	298	8	283
No. of specimens analysed	82	65	44	402	1688	117	315
Percentage in which salmonellas were detected†	36·6	13·8	18·2	5·2	16·4	6·0	73·7

† Some specimens contained more than 1 serotype.
* Samples described as mince or minced meat.

Table 3. *Isolations of predominant human salmonellas from cooked meats*

Serotype	Poultry	Pork products	Offal	Pet foods
S. typhimurium	0	1	1	13
S. hadar	1	3	0	11
S. virchow	1	0	0	1
S. agona	0	0	1	1
S. heidelberg	0	1	3	0
S. enteritidis	1	0	0	1
S. bredeney	0	1	0	12
S. stanley	0	2	0	0
S. indiana	0	0	0	0
S. saint-paul	0	0	0	2
Other serotypes	1	3	13	22
Total	4	11	18	63
No of specimens analysed	559	2490	869	279
Percentage in which salmonellas were detected*	0·7	0·4	2·1	19·7

* Some specimens contained more than 1 serotype.

Isolations of predominant human salmonellas from raw meats and sewer swabs from meat-handling premises are shown in Table 2. A large proportion of the samples examined were sausages and sewer swabs, and a comparison is made between isolations from these specimens and from humans in Table 4. Many of the sausages and sewer swabs were from one particular manufacturer (Manufacturer A) whose results are also shown in Table 4. This manufacturer was selected for more intensive sampling as the premises contained an abattoir and were used for the manufacture of raw and cooked meat products.

Isolations from cooked meats are shown in Table 3. Specimens examined included canned cooked meats such as corned beef and pork luncheon meat, pies, meat paste and sliced meats. Salmonellas were detected in less than 1 % of poultry and pork products and were not found in 1086 specimens of cooked beef or in 36 specimens of cooked lamb or mutton. Salmonellas were detected in 2·1 % of 869 cooked offal products. These included black pudding, brawn, tripe, udder, cowheel, faggots, oesophagus and haslet. Most of the salmonellas were isolated from tripe (11/251 specimens = 4·4 %) and udder (4/36 specimens = 11·1 %). *S. hadar* and *S. give* were isolated from two specimens of 'continental' sausage.

The isolation rate for cooked open pet foods was 19·7 % (J. M. Watkinson, personal communication). The predominant serotypes were *S. typhimurium*, *S. bredeney* and *S. hadar*.

Recognized phage types of *S. typhimurium* were recorded for 281 human isolates and covered 49 different types. The commonest was 204a in which 41 out of a total 45 isolates were isolated in 1980 followed by phage types 10 (20 out of 31 strains isolated in 1979–80) and phage type 44 (23/29 strains isolated in 1976). For raw meats and sewer swabs a total of 80 phage types were recorded and covered 29

Table 4. *The predominant salmonella serotypes isolation from humans, sausages and sewer swabs*

Humans	Incidents	Sausages	No.	Sewer swabs	No.
S. typhimurium	335	*S. derby*	56 (15)	*S. derby*	59 (33)
S. hadar	179	*S. typhimurium*	50 (6)	*S. panama*	28 (10)
S. virchow	109	*S. heidelberg*	18 (12)	*S. stanley*	25 (21)
S. agona	102	*S. panama*	18 (7)	*S. typhimurium*	24 (7)
S. heidelberg	80	*S. give*	17 (5)	*S. give*	23 (11)
S. enteritidis	56	*S. infantis*	14 (0)	*S. kedougou*	18 (13)
S. bredeney	54	*S. kedougou*	14 (6)	*S. bredeney*	16 (5)
S. stanley	48	*S. bredeney*	12 (2)	*S. agona*	13 (2)
S. indiana	41	*S. worthington*	11(2)	*S. heidelberg*	11 (6)
S. saint-paul	31	*S. london*	9 (1)	*S. london*	8 (2)
				S. worthington	8 (3)

Figures in parentheses: isolations from factory A.

different groups. The predominant type was 204 (9 isolates) followed by 204a (7 isolates). *S. typhimurium* was isolated from 13 specimens of cooked open pet foods. The commonest type was 204a (5 isolates) followed by 204 (3 isolates).

DISCUSSION

The predominant serotypes of salmonella isolated from humans in the Manchester area during the period 1976–80 were similar to those isolated nationally during a similar period (Hepner, 1980; Communicable Disease Surveillance Centre, 1981). An increase in isolations of *S. hadar* was reported from 1976 onwards by Rowe *et al.* (1980), who found that 46% of these outbreaks were caused by the consumption of contaminated turkey. A decrease in the number of isolations and reported causes of *S. hadar* was reported for England and Wales in 1980 when compared to 1979 (Communicable Disease Surveillance Centre, 1981). Incidents caused by *S. hadar* in the Manchester area followed a similar pattern for the period 1976–80 (Fig. 1) to those reported nationally. This serotype was responsible for a relatively high proportion of institutional outbreaks (12/30) and was isolated from foods implicated in three of these outbreaks. The food was turkey in one outbreak, beef in another and ham in the third. *S. hadar* was not common in any of the raw or cooked meats examined which were for human consumption but was one of the more common serotypes in cooked open pet foods.

For raw beef and pork, isolation rates of 5·2% and 13·8% respectively were found. A survey on the incidence of salmonellas in minced meats was carried out by the Public Health Laboratory Service (Report, 1980). Isolation rates of 2·3% and 4·6% were found for minced beef sold pre-packed and loose respectively and of 21·8% for minced pork. In the present study salmonellas were isolated from 16·4% of sausages. Roberts *et al.* (1975) found salmonellas in 29·7% of sausages, with average isolation rates of 11% for small manufacturers and 40–60% for large manufacturers. The main serotypes in the study of Roberts *et al.* were *S. infantis*, *S. agona* and

S. derby. In the present study they were *S. derby*, *S. typhimurium* and *S. heidelberg*. Sausages were reported to be the vehicle of infection in only 10 food poisoning outbreaks in Britain from 1967 to 1972 (Editorial, 1975); nevertheless, there exists the possibility of cross contamination with cooked meats.

The incidence of salmonella contamination in raw lamb and mutton was higher (18·2 %) than for beef and pork. This is due to an intensive sampling programme from shops in one particular locality selling lamb and poultry and in which poor hygiene was evident. Cross contamination was indicated by the occurrence of the same serotype in both poultry and lamb sampled from the same shop. It is considered more likely that the lamb was contaminated by the poultry as a high rate of contamination with salmonellas had been found in the poultry prior to delivery to the shops. In a survey of salmonellas isolated from sewer swabs from abattoirs (Report, 1964) a lower incidence of salmonellas was found in sewer swabs taken from premises where a high proportion of the animals slaughtered were sheep than where cattle were predominant. The isolation rate of salmonellas from poultry was 36·6 %. Sampling of the intestinal area by swabbing increased the number of isolations when compared to analysing samples of surface meat.

Isolation rates of salmonellas were much lower for cooked foods than for the corresponding raw foods. As with cooked foods the isolation rate for poultry (0·7 %) was higher than that for pork products (0·4 %). Salmonellas were not detected in cooked beef products, or in cooked lamb and mutton. A higher proportion of offal products were contaminated with salmonellas (2·1 %). These include black pudding, tripe, udder and oesophagus which may be futher cooked prior to consumption. Salmonellas were detected in 4·4 % of tripe and 11 % of udder specimens. These accounted for a total of 15 isolates, 9 of which were restricted to 3 producers whose products were sampled from a market stall within a period of a few weeks in connexion with a food poisoning case.

It is difficult to ascertain the relationship between salmonellas isolated from humans and those isolated from cooked foods for human consumption owing to low numbers of isolations from the latter. *S. typhimurium*, *S. bredeney* and *S. hadar* were the most frequently isolated serotypes from cooked open pet foods. These strains were also common in humans and, as with sausages, there exists the possibility of cross contamination with cooked meats, particularly in the home.

Large numbers of sewer swabs and sausages were analysed. As the sewer swabs were from meat-handling premises and would detect salmonellas originally present in raw meats a comparison has been made between serotypes isolated from humans, sausages and sewer swabs (Table 4). Serotypes commonly found in each of the three sources included *S. typhimurium*, *S. heidelberg* and *S. bredeney*. Predominant in sausages and sewer swabs but not in humans were *S. derby*, *S. panama* and *S. give*. Those commonly found in humans but not in sausages or sewer swabs included *S. hadar*, *S. virchow*, *S. enteritidis* and *S. indiana*, all of which are associated with poultry (Rowe, 1973, Rowe *et al.* 1980).

Phage types of *S. typhimurium* predominant in humans and in sausages and sewer swabs were 204a and 204. A high incidence of diarrhoeal disease due to *S. typhimurium* phage type 204a was observed from May to October 1980. Intensive

food sampling revealed the presence of this organism in cooked open pet foods and in raw poultry, bacon, lamb and beefburger. Reference has already been made to the poultry and lamb from shops where hygiene was not of a high standard. Phage type 204a was isolated from the faeces of several children who became ill after consuming meat from these shops, and subsequently their parents became ill.

The first human isolation of *S. kedougou* in this laboratory was in August 1976. Prior to that it had been isolated from sewage sludge taken from a sewage works in February 1976 and from uncooked pork products in March and May. This organism was the 13th most frequently isolated serotype from 1976 to 1980 in the present study and was one of the 10 most frequently isolated from sausages and sewer swabs.

To conclude, it can be seen that an association exists between the occurrence of certain serotypes of salmonella in meats and in humans. In the present study this was particularly evident for *S. typhimurium* phage type 204a. Other serotypes such as *S. derby* and *S. panama* were more common in raw meats and sewer swabs than in humans. Institutional outbreaks and family/contact outbreaks accounted respectively for 0·2 % and 20 % of all incidents. *S. hadar* and *S. enteritidis* were the serotypes most frequently associated with institutional outbreaks although family/contact outbreaks comprised a relatively low proportion of incidents caused by *S. enteritidis*.

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