

## ***Salmonella saint-paul* infection in England and Wales in 1959**

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### INTRODUCTION

The reported occurrence of human infection with *Salmonella saint-paul* in England and Wales increased from about three incidents annually before 1953 to nearly 100 in 1958 (Reports, 1954, 1955*a, b*, 1956, 1957, 1958, 1959*a*). The investigation described in this paper was carried out during 1959 to determine the source of infection.

*Salm. saint-paul* was first identified in 1940 (Edwards & Bruner, 1940), and since that time it has been found in human beings and animals in many parts of the world.

Behrmann & Adam (1957) reported an outbreak of infection in Hamburg, in which the affected persons purchased meat from one abattoir. Four of the staff of twelve at the abattoir were subsequently found to be excreting *Salm. saint-paul* and the organism was isolated also from minced meat. The authors did not ascertain the source of infection but suggested contaminated animal feedingstuffs because *Salm. saint-paul* had previously been isolated from mixed fish meal imported into Hamburg.

Table 1. *Human incidents of Salmonella saint-paul infection, England and Wales 1944-59\**

Year	No. of incidents	Year	No. of incidents
1944	1	1952	1
1945	2	1953	15
1946	2	1954	25
1947	1	1955	37
1948	Nil	1956	8
1949	2	1957	54
1950	1	1958	95
1951	3	1959	83

\* Abstracted from reports on food poisoning in England and Wales published in the *Monthly Bulletin of the Ministry of Health and Public Health Laboratory Service 1950-59*.

The number of incidents of human infection reported annually in England and Wales is shown in Table 1. The first incident occurred in 1944 (Report, 1947). Many of the incidents in 1953 and 1954 occurred in Bristol and South Wales but in the years 1955-57 most of them were in the West Riding of Yorkshire and Lincolnshire. One small outbreak was reported from Hull in 1955 and was associated with pork products from a local factory, although the organism was not isolated from these products. The source of infection was not indicated in any other incident. In 1958 the infection first appeared in the south of England, particularly the London area, and in that year there were fewer incidents in the north.

The isolations of *Salm. saint-paul* from non-human sources reported in Germany, the United States of America and England and Wales, are recorded in Table 2.

Table 2. *Isolations of Salmonella saint-paul from non-human sources 1940-58*

Material	Country	Author
Turkey poult	U.S.A.	Edwards & Bruner (1940)
Dogs	U.S.A.	Mackel, Galton, Gray & Hardy (1952)
Pigs	U.S.A.	Galton, Smith, McElrath & Hardy (1954)
Dogs } Pigs }	Germany	Hofmann & Wolle-John (1955)
Duck } Turkey }	U.S.A.	Bruner (1956)
Minced meat } Mixed fish meal }	Germany	Behrmann & Adam (1957)
Turkeys	U.S.A.	Watkins, Flowers & Grumbles (1959)
Pigs Dog Rat Poultry, Irish frozen egg Indian bone meal Bone meal (origin unknown) Dried blood	England and Wales, 1953-58	Isolations reported to the Public Health Laboratory Service

#### THE PRESENT INVESTIGATION

During 1959 there were 83 reported incidents of *Salm. saint-paul* infection comprising 89 cases and 28 symptomless excreters. As in previous years the highest incidence was between June and September, but the geographical distribution of the incidents was different from that of previous years and was almost entirely confined to the south of England (see sketch-map).

#### *Clinical features*

The highest incidence was found in young children. Diarrhoea was the usual symptom in most of the patients but in 10 out of 55 studied in detail the illness began with fever and malaise, and diarrhoea developed later or not at all. There

was one death in a man aged 50 years. The organism was isolated from pus from an abdominal abscess in a woman aged 41 years. A child of 8 months developed meningitis due to *Salm. saint-paul* about 10 days after a mild attack of diarrhoea. A boy aged 17 years who was admitted to hospital on account of severe headache was found to be suffering from *Salm. saint-paul* infection although the cerebro-spinal fluid was sterile. A girl of 17 years developed septicaemia and another patient, a male aged 21 years, developed a toxic confusional state associated with a generalized *Salm. saint-paul* infection.



Fig. 1. *Salmonella saint-paul*. Human and animal isolations, 1959. • = Human incident; × = animal incident; ■ = abattoir at which *Salmonella saint-paul* isolated.

### Source of infection

During April two incidents occurred in south-west England. The patients had been supplied with pork products from a single local abattoir (A) and subsequently a further six incidents occurred related to the same source of meat. Routine investigations of another abattoir (B) in the south of England led to the discovery of *Salm. saint-paul* infection in pigs. Seven incidents were associated with the products of this abattoir. An incident was considered to be associated with these abattoirs when within a period of 7 days before the onset of symptoms the household had purchased meat derived from either of them.

As stated, 15 incidents were found to have some association with the products of the two infected abattoirs. In all but one of these 15 incidents the meat concerned was pork or pork products, and in 11 it was either pork sausages or faggots. In another 33 incidents investigated no definite source of infection was found.

*Abattoir investigations*

Investigations at abattoir A were carried out between June and December 1959. Animals were purchased in south-west England from markets, farmers and dealers. The owner of the abattoir had a reputation for buying at low prices animals which were suffering from disease or injury. During each month about 1800 pigs, 900 sheep and 300 cattle were slaughtered. Most of the animals were killed within a few hours of arrival at the abattoir, but cattle and sows were sometimes kept in the lairages for up to a week, during which time there were opportunities for cross-infection to occur. At the premises of two dealers who supplied cattle and pigs regularly to the abattoir there were also found to be opportunities for cross-infection.

The abattoir supplied meat to wholesale butchers in south-west England and also sent pig carcasses to London, but the main business was the sale of meat products which were manufactured in a factory adjacent to the slaughterhouse. These products were sold locally and in the Channel Islands and it is interesting that one human *Salm. saint-paul* incident occurred in Guernsey in 1958 although the source of infection was not found.

The results of the examination of animals and meat products at this abattoir are shown in Table 3. Both pigs and cattle were found to be infected. The pigs showed no symptoms but one positive specimen of a mesenteric gland was obtained from a cow slaughtered because it was suffering from acute enteritis. The farm of origin of this cow was investigated with negative results. However, it was ascertained that the animal had passed through the premises of two dealers before reaching the abattoir and it is probable that the infection was acquired on one of these premises or during transit.

Fifteen other farms and the premises of two other dealers were investigated, either because the animals they supplied to the abattoir were found to be infected at slaughter, or because it seemed likely that they had been the cause of a positive sewer swab. A total of 52 specimens of animal faeces and 62 specimens of animal feedingstuffs was examined but salmonellae were not isolated.

Three specimens of faeces were collected from the abattoir lairages and one of these contained *Salm. saint-paul*.

Pork sausages manufactured from pigs slaughtered in this abattoir were contaminated on two out of thirty-two occasions. No salmonellae were found in cooked products but the number of specimens examined was small.

One pork sausage from a batch found to be contaminated was cooked in lard at 162° C. for 5 min., at the end of which it was black on one side and pinkish brown on the other. *Salm. saint-paul* was isolated from 1 g. of meat removed from the centre of the sausage after it was cooked.

Investigations at abattoir B were carried out between June and November 1959. Only pigs were slaughtered in this abattoir and these were purchased from markets, dealers and farms in the south of England. The number of animals killed varied but was usually about 1000 per week. As at abattoir A, most of the pigs were killed within a few hours of arrival, but sows were kept together in the lairages

for several days at a time, during which cross-infection may have occurred. About nine-tenths of the pigs were sold in London and the remainder locally. The results of the examinations at this abattoir are also shown in Table 3. *Salm. saint-paul* was isolated once from a mesenteric gland of a pig and four times from sewer swabs. There were no reports of illness in the animals at this abattoir.

Table 3. *Examinations at abattoirs*

Specimen	Proportion containing Salmonellae	Serotypes isolated	
Abattoir 'A'			
Pig mesenteric glands	9/33	<i>saint-paul</i>	(9)
Cow mesenteric glands	8/16	<i>saint-paul</i>	(8)
Pig rectal swabs	4/28	<i>saint-paul</i>	(4)
Faecal specimens from lairages	1/3	<i>saint-paul</i>	(1)
Sewer swabs	5/14	<i>saint-paul</i> <i>give</i>	(4) (1)
Pork sausage	2/32	<i>saint-paul</i>	(2)
Beef sausage	0/2	—	
Cooked meats	0/7	—	
Abattoir 'B'			
Pig caecal swabs	2/66	<i>heidelberg</i> <i>typhimurium</i>	(1) (1)
Pig mesenteric glands	1/66 (same animals as above)	<i>saint-paul</i>	(1)
Sewer swabs	15/41	<i>anatum</i> <i>bredeney</i> <i>derby</i> <i>heidelberg</i> <i>saint-paul</i> <i>senftenberg</i> <i>typhimurium</i>	(6) (6) (4) (1) (4) (1) (2)
Pork sausage	0/9	—	
Cooked dog meat	0/9	—	

A comparison of the origins of pigs slaughtered on the 4 days on which *Salm. saint-paul* was isolated from sewer swabs suggested that infected animals were coming from one particular market in the west of England. The organism was later isolated from the mesenteric gland of a pig from this market. Faecal specimens were collected at this market on two days. From 336 specimens, *Salm. typhimurium*, *Salm. anatum*, *Salm. minnesota* and *Salm. newport* were all isolated once. *Salm. saint-paul* was not found.

#### *Investigations of disease in animals*

The Central Veterinary Laboratory reported the isolation of *Salm. saint-paul* on ten occasions in 1959. Six of the isolations were from turkey poults suffering from enteritis and these birds were all derived from one hatchery in East Anglia.

The mode of infection at this hatchery was not discovered. The mortality among the poults varied from 3% to 50% in five outbreaks of enteritis about which information was obtained. There were three apparently unrelated isolations from cattle suffering from enteritis in South Wales. Investigation on one of the farms led to the conclusion that the infection was probably derived from contaminated animal feedingstuffs, but the types of feedingstuffs in use at the time the animal's symptoms developed could not be ascertained.

One outbreak of enteritis occurred in chicks in the west of England in June 1959 and six out of 150 birds died. The chicks fell ill some 2 weeks after purchase from a Sussex hatchery. Six birds of a similar age were later obtained from the same hatchery and salmonellae were not isolated from liver, spleens or intestines, nor was there serological evidence of salmonella infection. No other animals had been brought into the farm within the previous 8 months and it was thought that the *Salm. saint-paul* infection probably arose from a contaminated animal feedingstuff on the farm.

Faeces were examined from the chicks at the age of 8, 16 and 24 weeks and on each occasion were found to contain *Salm. saint-paul*. Cloacal swabs were collected when the birds were killed at 28 weeks and five out of 140 (3.6%) were found to be still infected. Faeces were collected from other animals on the farm at each visit. These showed that a batch of four pigs, originally not found to be infected when examined soon after purchase, were at the next visit 2 months later excreting *Salm. saint-paul*.

Table 4. *Salmonellae* isolated from 101 samples of American meat meal—January–April 1960

Serotype	No. of isolations	Serotype	No. of isolations
<i>agama</i>	1	<i>kentucky</i>	15
<i>albany</i>	1	<i>livingstone</i>	2
<i>anatum</i>	8	<i>madelia</i>	1
<i>bareilly</i>	2	<i>meleagridis</i>	12
<i>binza</i>	2	<i>minnesota</i>	2
<i>braenderup</i>	1	<i>montevideo</i>	24
<i>bredeney</i>	2	<i>newington</i>	5
<i>california</i>	6	<i>oranienburg</i>	2
<i>cerro</i>	26	<i>paratyphi B</i>	1
<i>champaign</i>	1	<i>paratyphi B</i> var. <i>java</i>	1
<i>chester</i>	6	<i>san-diego</i>	1
<i>cubana</i>	4	<i>schwarzengrund</i>	3
<i>derby</i>	8	<i>senftenberg</i>	19
<i>halmstad</i>	1	<i>tennessee</i>	3
<i>havana</i>	1	<i>urbana</i>	3
<i>indiana</i>	1	<i>worthington</i>	19
<i>infantis</i>	3	<i>unidentified</i>	1
<i>johannesburg</i>	27		

The animal feedingstuffs in use on this farm were examined and *Salm. saint-paul* was isolated from wheat and barley meal and *Salm. anatum* from poultry meal. The wheat and barley meal was ground on the farm from wheat and barley grown

locally. It was considered that the meal was contaminated on the farm by infected poultry or dust from other foodstuffs. The poultry meal was a compound feedingstuff containing, as its protein constituent, meat meal imported from America, where infection with *Salm. saint-paul* is widespread in animals (Bruner, 1956). The firm producing the poultry meal, which was one of the largest producers of feedingstuffs in the country, had imported American meat meal since early 1958 and had used it in their mills distributing to the south of England.

Between January and April 1960, 101 samples of American meat meal were examined and salmonellae were isolated from 93. From 53 of the samples, two or more serotypes were isolated. A total of 34 different serotypes was isolated and these are listed in Table 4. *Salm. saint-paul* was not found.

#### BACTERIOLOGICAL METHODS

Faecal specimens were collected with sterile wooden spoons and conveyed to the laboratory in glass universal containers. Rectal swabs consisted of cotton-wool on wooden sticks. By means of these, material was collected after the animal had been slaughtered but before evisceration. Caecal swabs were obtained by puncturing the caecum with a knife and then inserting the swab. The knives were cleaned and stood in 70% alcohol for 5 min. between each use. Glands were cut out of the mesentery with their surrounding fat and conveyed to the laboratory in sterile glass jars. At the laboratory, the fat was dissected away leaving a complete gland which was dipped in boiling water for about 5 sec. A piece of tissue was then removed from the centre of the gland for culture.

The specimens were cultured in both selenite F (Hobbs & Allison, 1945) and tetrathionate broth (Rolfe, 1946). Subcultures were made on to solid media after incubation for 24 and 48 hr. at 37° C. Three solid media were used: (1) Wilson and Blair, (2) deoxycholate citrate agar, and (3) brilliant green-neutral red-Teepol agar with 1% lactose and 1% sucrose.

The samples of meat meal were incubated with nutrient broth, or quarter strength Ringer's solution, for 2 hr. at 37° C. and then an equal volume of double strength selenite F medium was added. After further incubation at 37° C. overnight, subcultures were made on to solid media. Suspicious looking colonies were subcultured in tubes containing a triple-sugar medium, consisting of 0.5% lactose, sucrose and salicin in peptone water. All tubes of triple-sugar medium were plated out after a period of 6 hr. incubation on to MacConkey agar to test for purity, and to provide material for identification, by serological means, of the non-lactose-sucrose-salicin fermenting organisms isolated.

#### DISCUSSION

The investigation of *Salm. saint-paul* infection in England and Wales in 1959 showed that 15 out of 48 incidents were related to home-produced meat. Nearly all the 83 incidents reported during the year occurred in the south of England, where animal infection was found to be present, and it is therefore probable that

more than 15 were related to home-produced meat. Infection in poultry was discovered but this did not appear to be the source of infection in any of the 48 incidents studied.

Clinical histories were obtained from 55 of the 89 patients. There was one death. The symptoms of ten patients were not typical of food poisoning because the illness began with fever and malaise and only five of these patients subsequently developed diarrhoea. Two of the ten patients developed focal infection, one meningitis and the other an abdominal abscess. Clarenburg, Vink & Minkenhof (1949) reported a case of septicaemia due to *Salm. saint-paul* infection, and Saphra & Winter (1957) state that in a series of 133 persons (cases and symptomless excretors) infected with *Salm. saint-paul* or *Salm. san-diego*, 7.6% had typhoid-like illnesses and 6.0% developed focal manifestations.

Infection in animals was demonstrated at two abattoirs, and at one of these it was clear that the organism was being brought in by sick animals. This practice of killing sick animals in abattoirs handling meat for human consumption is clearly undesirable and should be prohibited. In the other abattoir the mode of entry of the organism was not found. Cross-infection among pigs kept together in large numbers for long periods before slaughter has been shown to be an important factor in the production of a high rate of infection in the abattoir (Galton, Smith, McElrath & Hardy, 1954; McDonagh & Smith, 1958) and it is probable that this contributed to the infection in the two abattoirs described. No information was obtained regarding the mode of spread of the infection within the abattoir but it is probable that surface contamination of carcasses with faeces was an important factor.

Although infection and illness in farm animals was found, the source of their infection was not discovered. Animal feedingstuffs are known to be contaminated with salmonellae (Walker, 1957; Report, 1959*b*) and *Salm. saint-paul* has been isolated in the past from bone meal, dried blood and fish meal, all of which may be used for animal feedingstuffs. Epidemiological evidence in one outbreak of infection in chicks led to the investigation of American meat meal as a possible source of *Salm. saint-paul*. Although the material was heavily contaminated with salmonellae, this organism was not isolated. Nevertheless, imported animal feedingstuffs were thought to be the most probable origin of the infection.

#### SUMMARY

An investigation of *Salm. saint-paul* infection in England and Wales in 1959 is described. In one-third of the human incidents the infection was attributed to home-produced meat coming from two infected abattoirs.

Animal infection was demonstrated and was probably due to contaminated imported animal feedingstuffs.

The clinical histories of 55 of the 89 cases reported during the year were studied. There was one death. In ten patients the illness commenced with fever and malaise and diarrhoea was absent or did not occur until 24–48 hr. later. One patient developed meningitis and another an abdominal abscess.



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