

A large outbreak of human salmonellosis traced to a local pig farm

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SUMMARY

An outbreak of *Salmonella typhimurium* definitive type (DT) 193 affecting 206 persons occurred in July and August 1989 in a small town in northern England. A descriptive study suggested that cold meats including pork from a butcher's shop in the town were vehicles of infection. An analytical study of a cohort attending a function in the town showed a significant association between illness and consumption of cold roast pork supplied by the butcher's shop ($P = 0.00000004$). *S. typhimurium* DT 193 with the same antibiotic resistance pattern (to ampicillin, streptomycin, sulphonamides and tetracyclines) as the outbreak strain, and possessing a single plasmid of 80 MDa was isolated from samples of meat bought from the shop and implicated in illness, and from samples of pig faeces taken from the farm supplying the shop. It was concluded that inadequate processing of infected pork meat at the shop may have contributed to this outbreak but that cross contamination also played an important part in transmission. Control measures included a temporary closure of the shop and subsequent implementation of a detailed protocol for meat processing and monitoring of all procedures at the shop.

INTRODUCTION

Salmonella infection is a major cause of food poisoning in England and Wales: 25337 isolates of salmonellas (cases and excretors) were reported by Public Health Laboratory Service (PHLS) and reporting NHS laboratories in England and Wales (E & W) to the Communicable Disease Surveillance Centre (CDSC) during 1990. This figure represented an increase of over 44% from 1987 (17552 isolates). In 1987 laboratory reports of *S. typhimurium* infections accounted for 36% of reports, and in 1990, constituted just 18% of all reported salmonella infections. *S. enteritidis* has comprised an increasing proportion of isolations in recent years.

In late July 1989, staff of an Environmental Health Department (EHD) in northern England were informed of an 11-year-old girl with *S. typhimurium* food

poisoning. She had recently attended a function at a local club. Reports soon followed of further cases of *S. typhimurium* food poisoning among people who had attended this and other functions held in the town. The functions had been supplied with cold meats from the same local butcher's shop. A total of 30 people with *S. typhimurium* infection was reported in one week. The PHLS Division of Enteric Pathogens (DEP) confirmed the identity of the outbreak strain as *S. typhimurium* DT 193 resistant to ampicillin, streptomycin, sulphonamides and tetracycline, and possessing a single plasmid of size 80 MDa. Twenty-three isolations of *S. typhimurium* DT 193 had been reported from the whole of the Northern Region in 1986, 32 in 1987, and 27 in 1988. The assistance of CDSC in the investigation was requested and a Control of Infection Committee was convened. This paper describes the methods and results of the investigation carried out.

METHODS

A definite case was defined as a person with any gastro-intestinal symptoms with onset of illness after 14 July 1989, and from whose stools *S. typhimurium* was cultured; a confirmed case was a person with gastro-intestinal symptoms whose stools were positive for *S. typhimurium* DT 193.

Descriptive study

Cases were interviewed by telephone using a semi-structured questionnaire designed to enquire about cold meats and other foods consumed in the 7 days before onset of illness as well as the nature and severity of illness.

Analytical study

A cohort study was carried out to determine if any foods or drinks served at a certain function held in the town were associated with illness. A full list of food items available at the function was provided by EHD staff. Persons who attended the function were interviewed by telephone using a structured questionnaire enquiring about symptoms and foods eaten. Food specific attack rates were calculated and the statistical tests used were Yate's corrected chi-squared two tailed test, Fisher's two tailed exact test, and Cochran's test for independence of risk factors.

The butcher's shop, which had supplied cold meats to this and other functions held in the town, and an abattoir located at the back of the shop, were inspected by staff of the local EHD and the PHLS. All procedures, including those for processing and storing meats in the shop, were examined in detail.

Staff from the PHLS laboratory visited the local farm supplying pigs to the abattoir, and took individual faecal specimens from pigs in the pig unit. The farm was also visited by staff of the Veterinary Investigation Centre (VIC), Ministry for Agriculture Fisheries and Foods (MAFF), Newcastle on Tyne. A further visit to the farm was later made and pooled faecal samples were taken and a Moores swab placed down a drain leading from the pig unit. These samples and the swab were examined at the Central Veterinary Laboratory in Weybridge, and confirmation

of identity and phage typing was carried out at the DEP. Strains of *S. typhimurium* isolated at local laboratories were also forwarded to the PHLS DEP for confirmation of serotype, phage typing, resistance typing, and plasmid profile analysis.

RESULTS

Altogether 206 cases (31 confirmed and 175 definite), as well as an additional 69 suspected cases were reported during July and August 1989; of the 206 cases (100 male and 106 female), 125 (61%) were aged 15–44 years, while 24 (12%) were aged over 60 years and 23 (11%) were aged 14 years or less. The earliest date of onset of illness was 15 July and the latest 12 August 1989 (Fig. 1). A peak in numbers of reported cases was observed during 21–24 July.

Descriptive study

Ninety-one cases (80 definite and 11 confirmed) were interviewed in the descriptive study. Of these 42 were male, 49 were female, and 6 were thought to be secondary household cases. Eighty-five (93%) cases reported diarrhoea (i.e. three or more loose stools in a 24 h-period) and blood in the stools was noted by 15 cases. Eighty-three (91%) complained of abdominal pain. 75 (82%) felt feverish, 70 (77%) reported a loss of appetite, and headache (or flu-like symptoms) was reported by 67 (74%). Sixty-three (69%) felt nauseated and 49 (54%) reported vomiting. The duration of illness ranged 1–21 days, with a median duration of 6 days. Eleven cases reported an on-going illness at the time of the interview. The number of days normal activity lost by cases ranged 1–21 days with a median of 7 days lost. Seventy-five (82%) cases attended their General Practitioner, and 19 were admitted to hospital.

Of 85 primary cases interviewed, 76 (89%) reported that they definitely ate cold cooked meats; forty-seven (55%) of these 76 reported eating cold roast pork and 25 (33%) said that they had eaten loose roast or boiled ham in the week before the onset of illness.

Of 11 confirmed cases interviewed, all reported eating cold meat: 9 specified pork meat; 1 ate loose roast ham; and 1 was unsure which meat had been eaten. Nine of the 10 who recalled which meat was eaten reported that the meat had been bought at the suspected butcher's shop.

Cohort study

In addition, a questionnaire was completed for 58 of 59 persons who attended the same function in the town on 20 July 1989. Thirty persons fulfilled the clinical case definition. Two asymptomatic persons who had positive stool cultures of *S. typhimurium* and one possible case with a history of nausea and stomach pain only were excluded from the analysis.

A significant association was found between illness and consumption of pork sandwiches, sausage rolls, ham and pease pudding sandwich, sausages on sticks and pickled onions (Table 1). Cochran's test for independence of risk factors showed that consumption of pork sandwiches was the only factor which was independent of all other associations. Roast pork, ham, and pease pudding had been supplied by the suspected butcher's shop.

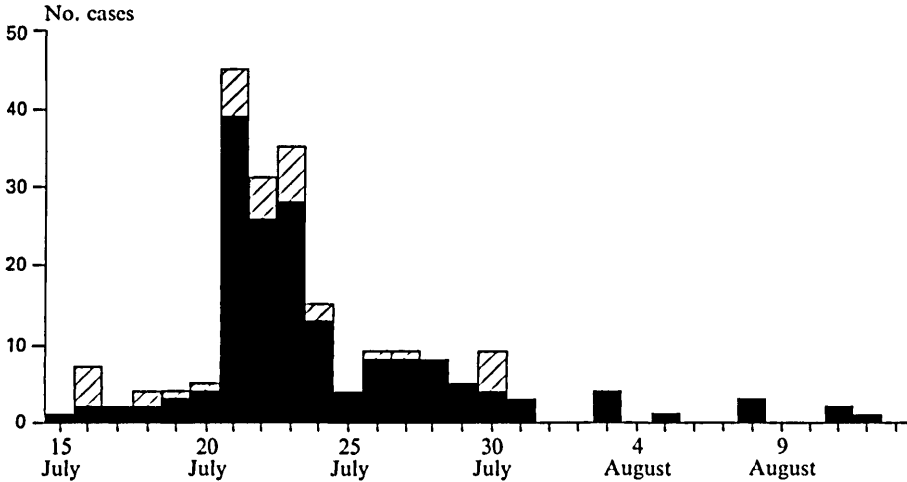


Fig. 1. *S. typhimurium* DT 193. Onset dates definite and confirmed cases. ■, Definite; ▨, confirmed. Onset date was uncertain in four cases.

Table 1. Cohort study: food specific attack rates

Food	Ate			Did not eat			Yates's corrected chi squared 2 tailed test P value
	Ill	Not ill	Ill (%)	Ill	Not ill	Ill (%)	
Sausage rolls	22	7	(76)	8	18	(31)	0.002
Egg and tomato bun	9	6	(60)	21	18	(54)	NS
Tuna and mayonnaise bun	9	12	(43)	19	12	(61)	NS
Cheese savory bun	12	7	(63)	18	18	(50)	NS
Pork sandwich	24	1	(96)	5	24	(17)	0.00000004†
Ham and pease pudding sandwich	15	3	(83)	14	22	(39)	0.005†
Ham sandwich	5	2	—	23	23	(50)	NS‡
Sausages on sticks	14	4	(78)	15	20	(43)	0.03
Pickled onions	18	7	(72)	12	18	(40)	0.04
Crisps	16	14	(53)	14	11	(56)	NS
Nuts	14	9	(61)	16	16	(50)	NS
Other	2	2	—	21	18	(54)	NS‡

* NS, Not significant.

† Supplied by suspect butcher's shop.

‡ Fisher's Two-tailed exact test.

Environmental and microbiological

Meat preparation, processing and storage was carried out at the rear of the butcher's shop. On day one, after deboning and bagging, up to 10 large pieces of ham or legs of pork were placed in a boiler with an equal volume of cold mains tap water. After 6 h the boiler was switched on by a time switch with the thermostat set at 80 °C, and 8 h later the current was switched off. The thermostat on the boiler was not checked routinely against a thermometer reading and no internal probes were used to check the temperature at the core of the meat. Tests revealed that it took 2 h 20 min to reach the set temperature in the boiler and that one of

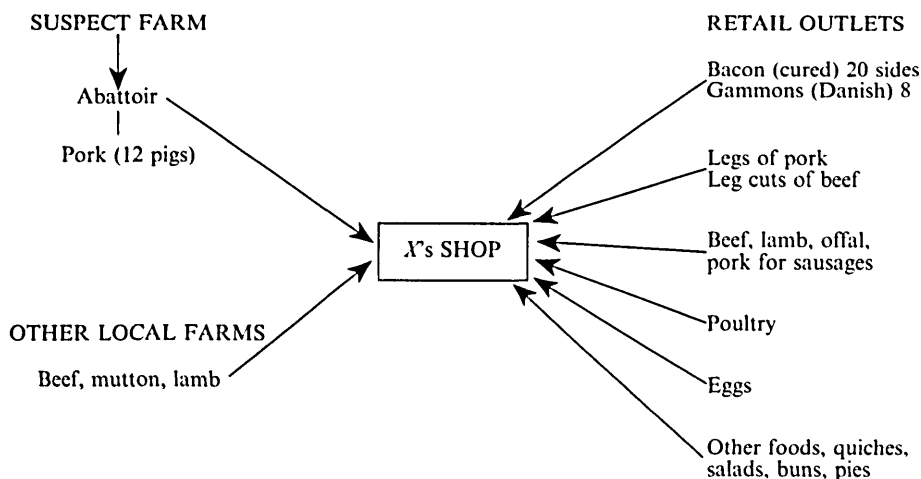


Fig. 2. Weekly meat and food supply to X's shop.

the elements in the boiling device had burnt out. On day two, the cooked meat was placed in a cooling bath through which cold water was run. The supply to the bath was interrupted whenever a competing demand occurred elsewhere on the premises. Ham pieces were transferred to the cold store for slicing and sale on day three and subsequent days. Pork pieces were debagged and flash roasted for 30–45 min, in an oven set at 260 °C. The pork pieces were then taken from the oven and left at ambient temperature until the next day on a bench in the same area as the oven. Following this they were transferred to the cold store to harden. The shop was well maintained and clean, and cooked meats were stored separately from raw meat. One mixed sample of pork and ham, bought at the shop by an affected person, and one sample of cooked ham, associated with illness, and obtained from the home of another affected individual yielded *S. typhimurium*. In addition a sample of raw pork meat bought from the shop on 20 July but not associated with illness yielded *S. typhimurium*. All three strains were confirmed as *S. typhimurium* DT 193, resistant to ampicillin, streptomycin, sulphonamides and tetracyclines, and possessing a single plasmid of 80 MDa.

Eleven meat samples taken from the shop on 26 July were negative for bacterial pathogens. Twelve processed meat products taken from the shop after its closure were also negative for *Salmonella* species but a core sample from a piece of refrigerated cold 'roast' pork yielded coliforms at a concentration of 25 per gm. No food was available from any of the functions associated with the outbreak.

Environmental swabs from work benches and equipment, and seven drain swabs placed at the premises were negative on culture.

Five suppliers were known to provide meats to the butcher (Fig. 2), but, during July 1989, all pork processed or sold at the shop originated from the same local pig farm. The farm housed 1400 animals, in 28 pens, with continual restocking and minimal exchange between pens. After 10 weeks in the pig unit, the pigs were sent for slaughter. Of 20 pigs slaughtered each week at the abattoir at the rear of the butcher's shop, 12 carcasses were supplied to the shop. Although a small number of pigs from other farms were slaughtered at the same abattoir, there was

apparently no likelihood that a carcass from another farm was supplied to the butcher's shop during July 1989.

Faecal specimens ($n = 24$) taken from pens at the farm on 1 and 2 August 1989 were negative on culture. Pooled faecal samples taken on 11 August from four groups of pens at the farm, and the Moores swab placed on 11 August yielded *S. typhimurium* on enrichment. The strains were later confirmed as *S. typhimurium* DT 193, resistant to ampicillin, streptomycin, sulphonamides and tetracyclines, and possessing a single plasmid of size 80 MDa.

Control measures

The shop was closed voluntarily on 28 July. Seventeen of the 18 staff members provided a stool specimen (one was on holiday). Sixteen were asymptomatic, but one staff member who had eaten a pork chop and a ham and pease pudding from the shop on 20 and 21 July respectively, became ill on 22 July. All 17 stool cultures were negative including that from the symptomatic staff member. All processed meats remaining in the shop were removed and destroyed. All surfaces within the shop were treated with hypochlorite solution. Check swabs taken 2 days later yielded no bacterial growth.

Recommendations were made, designed to reduce the risk of cross contamination at the shop, and a protocol for meat processing procedures was drawn up. These included the use of a temperature probe for monitoring of the temperature achieved in meat during cooking, new equipment for meat cooling, and improved hand washing facilities. All were subsequently implemented. A 'trial run' using the recommended new processing procedures was carried out in late August and as core and other samples of meat were negative on culture, and internal temperatures achieved during cooking of the meat were satisfactory ($> 70\text{ }^{\circ}\text{C}$), the shop resumed usual trading.

DISCUSSION

This outbreak, in the summer of 1989, occurred at the same time as three other large outbreaks of salmonella food poisoning, in England and Wales, investigated by the CDSC, and found to be associated with consumption of cold cooked meats [1]. Two of these outbreaks were caused by commonly isolated *S. typhimurium* phage types (12 and 193) and two others by more unusual serotypes (*S. kedougou* and *S. falkensee*). The total number of people affected in the four outbreaks was at least 897 [2]. The cost of a large nationwide outbreak of salmonella infection in 1982, affecting 245 people, was estimated as approximately £0.5 million sterling [3], and the economic impact of these outbreaks was therefore likely to have been considerable.

A link between this outbreak of *S. typhimurium* DT 193 infection and consumption of cold roast pork and other cold meats supplied by the same butcher's shop in the town was suspected early in the investigation. Press and media coverage highlighted the closure of the shop and may have introduced bias in reporting by persons who were ill. In addition, the butcher was known to supply large numbers of the local population and thus might have been implicated by chance. Therefore, it was decided to carry out an analytical study. The cohort

study established a strong statistical association between the illness and consumption of cold roast pork which had been supplied by the butcher's shop. The results of the descriptive study suggested that a number of other food items including ham, cold roast beef, pork pies and tongue bought from the shop and from other outlets supplied by the shop may also have been vehicles of infection in this outbreak.

Microbiological evidence supported the hypothesis that roast pork and other cold meats supplied by the shop were vehicles of infection as *S. typhimurium* DT 193 with the same antibiotic resistance pattern as the outbreak strain was isolated from samples of cold cooked ham and pork implicated in illness and from raw pork bought from the shop. We conclude that the outbreak may have been attributable to a number of factors which include a processing failure of cooked pork meat contaminated with *S. typhimurium* DT 193, a breakdown of hygiene standards at the shop allowing cross contamination from raw to cooked meats, and cross contamination of other cold meats and other foodstuffs after purchase and during food preparation.

Laboratory reports to the (DSC) have shown an almost continuous increase in salmonella isolations since the 1950s. A peak observed during the 1950s was attributed to infection in cattle and in the late 1970s to infection in poultry [4]. Several outbreaks of salmonellosis in England associated with cold cooked meats including roast pork and cooked ham in the 1970s affecting at least 550 people have been reported [5-7]. Inadequate cooking of large joints of meat, which were then allowed to cool at room temperature for several hours was noted. Thirty-six reported sporadic salmonella infections and 27 family outbreaks of salmonellosis after eating cold roast pork in one English region were also thought to be due to inadequate cooking of meat joints and prolonged cooling at room temperature [7]. A survey of cooked and raw meat products in England found that salmonellas were present in less than 0.5% of most cooked meat, with an isolation rate of 3% from raw pork and 12% from raw sausage meat [8]. In our investigation at the butcher's shop, procedures for meat processing were poorly monitored and may have been deficient. It was possible that the amount of meat handled may have exceeded the capacity of the cooking process, and that if large numbers of *S. typhimurium* had been present in a pig carcass arriving at the shop, some might have survived the cooking process. It has been suggested that commercial pressures to minimize the shrinkage resulting from thorough cooking of meat joints may lead to the production of a microbiologically unsatisfactory product [9].

In this outbreak a link with the local farm supplying pigs to the abattoir and thence to the butcher's shop was established; *S. typhimurium* DT 193 with the same antibiotic resistance pattern as the outbreak strain and the same plasmid profile was isolated from pigs faeces and a drain swab taken during investigation of the farm where the pigs originated. This resistance pattern and plasmid profile were important in the epidemiology of this outbreak as *S. typhimurium* DT 193 is a heterogenous group [10]. The close cooperation and joint working of all involved in the epidemiological and environmental investigation played an important part in establishing such a link.

In an earlier outbreak of *S. indiana* food poisoning affecting 120 people

associated with cooked pork, a link was suspected but not confirmed with the live pigs being supplied to the processing factory [11].

In the United States of America multistate outbreaks have also been reported associated with pre-cooked meats [12]. Regulations were introduced in the USA in 1977, requiring joints to be cooked until heated throughout to at least 62.8 °C. In the United Kingdom, the Richmond Committee report has recommended the implementation of the Hazard Analysis and Critical Control Point system in food manufacturing, and recommended a minimal cooking temperature of 70 °C for at least 2 min [13].

This outbreak occurred simultaneously with three others, during the particularly warm summer of 1989 and serves to emphasize the importance of adequate cooking of large joints of meat and vigilance in maintaining good standards of hygiene in food preparation. In order to reduce the potential threat to the public health of food poisoning related to inadequate processing of foods, efforts should be made to ensure that the recommendations of the Richmond Committee are implemented as soon as possible.

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