

A national outbreak of *Salmonella typhimurium* DT 124 caused by contaminated salami sticks

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SUMMARY

An outbreak of *Salmonella typhimurium* DT 124 infection which affected 101 people in England in December 1987 and January 1988 was detected through surveillance of laboratory reports from medical microbiology laboratories of the NHS and PHLS. Within 1 week of noting the increase in reports, epidemiological and microbiological investigations identified a small German salami stick as the vehicle of infection and the product was withdrawn from sale. The epidemiological investigation highlighted the occurrence of a long incubation period, bloody diarrhoea. Prompt recognition and investigation of the outbreak prevented further cases of severe infection.

INTRODUCTION

Salmonella typhimurium definitive type (DT) 124 is an unusual phage type in the UK. From 1982, the first year of reporting this phage type, to 1986, the Public Health Laboratory Service (PHLS) Communicable Disease Surveillance Centre (CDSC) received a total of 19 reports of human faecal isolates and no reports of isolations from food in the UK.

On Monday 25 January 1988, CDSC received 15 laboratory reports of *S. typhimurium* DT 124 infections through the weekly laboratory surveillance scheme. The previous week, there has been 6 such reports; 3 in the week before; and 9 in the whole of 1987. The sudden increase in reports suggested a common source of infection and an epidemiological investigation was carried out.

METHODS

Epidemiological

Preliminary enquiries were made to determine if there was a food common to those infected with *S. typhimurium* DT 124. The PHLS Division of Enteric Pathogens (DEP) provided CDSC with a list of 15 recent cases. The reporting laboratories were contacted to obtain the name of each case's general practitioner (GP). The GP was then contacted to obtain the case's clinical details, and permission to conduct an interview. All 15 cases were interviewed in person using a wide-ranging, but structured, questionnaire. The enquiry suggested that a small German salami stick was the possible vehicle of infection. Salami sticks, among other foods named by cases, were obtained from the households of cases or from retail outlets they used and were delivered to the PHLS Food Hygiene Laboratory (FHL).

A case-control study was then undertaken to test the hypothesis that consumption of the salami sticks was associated with *S. typhimurium* DT 124 infection. Persons were considered to be primary cases if they had had diarrhoea, the epidemic phage type isolated from their stools, and no other member of the family had previously had diarrhoea since 1 December 1987. Persons were considered to be secondary cases if they satisfied the clinical and microbiological criteria of primary cases, but another household member had previously had diarrhoea, since 1 December. Cases interviewed in the preliminary study were ineligible for inclusion in the case-control study. Three controls, closely matched for place of residence, age, and sex if over 11 years old, were nominated by persons in the case household. A telephone administered questionnaire enquiry was undertaken and information was obtained on personal and clinical details, as well as recent foreign travel. A detailed food history was obtained on various generic meat items; on specifically named meat items including the suspected product; and on some chocolate items, including named sweet products, as chocolate had been implicated in an earlier outbreak of salmonellosis (1). Information was requested on foods eaten in the 3 days, and the week, before the onset of symptoms as it was apparent from the preliminary enquiry that some cases had eaten the salami stick more than 3 days before they became ill. Following the case-control study a descriptive study of the remaining cases was carried out by telephone interview.

Microbiological

Salami sticks were chopped and blended with a small volume of 1% buffered peptone water (BPW) and pre-enriched in 225 ml of BPW at 37 °C. After overnight incubation the BPW was subcultured to brilliant green (BG) and Liefson sucrose (LS) agars and 10 ml volumes transferred to 100 ml volumes of Selenite and Tetrathionate (Rolfe) broths. The secondary enrichment broths were subcultured to BG and LS agars after 24 and 48 h incubation at 43 °C. Plates were incubated at 37 °C for 24 or 48 h. Colonies giving the appearance of salmonella were rapidly screened by testing with polyvalent and 04 salmonella antisera and those giving a positive reaction were sent to DEP for phage typing. Colonies were also confirmed as salmonella by the appropriate biochemical tests. *S. typhimurium*

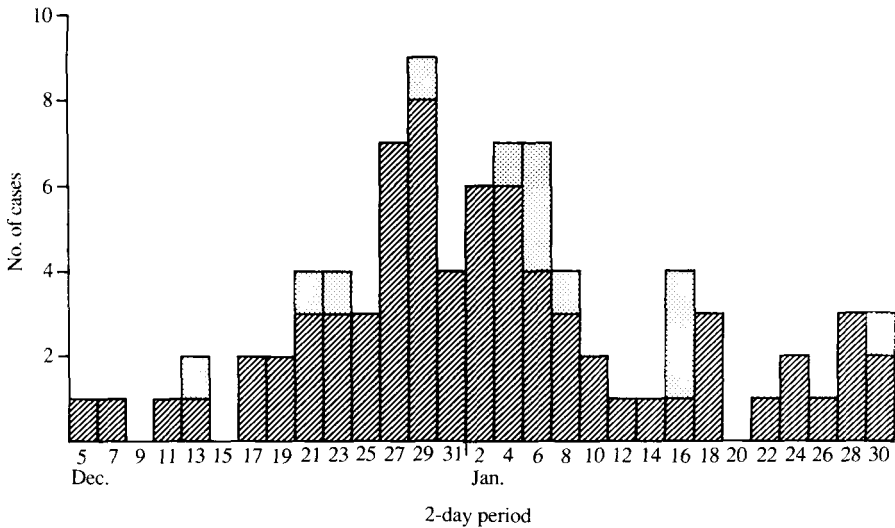


Fig. 1. Epidemic curve ($n = 85$). ▨, Primary case; □, Secondary case.

strains received by DEP were phage typed by the method described by Callow (2) and given the definitive type (DT) as developed by Anderson and colleagues. (3).

RESULTS

Epidemiological

Descriptive epidemiology

Of 101 confirmed isolates of the epidemic strain reported by DEP between 1 December 1987 and 29 February 1988, 85 were interviewed by CDSC investigators in either the preliminary, case-control, or detailed descriptive investigations. Of these 85, 72 were primary cases, and 13 were secondary. There were 46 males and 39 females. Ages ranged from 7 months to 78 years, although most were children and the median age was 6 years. Cases were concentrated in south-east England (Fig. 1). The dates of onset of illness in primary cases were between 5 December 1987 and 30 January 1988 (Fig. 2). Of the 72 primary cases, 68 had eaten the salami stick in the week before the onset of symptoms.

Eighty-one out of 85 cases reported diarrhoea, 35 reported blood in their stools, 38 reported vomiting and 71 fever; 2 cases developed complications. A 14-year-old girl who was admitted to hospital and was diagnosed as a case of acute appendicitis had an appendicectomy, and a 16-year-old boy developed acute ulcerative colitis. In 59 primary cases for whom the dates of consumption and onset were known, 5 had an incubation period of under 24 h, 41 between 1 and 3 days, 11 between 4 and 7 days and 2 had an incubation period of more than 7 days. Illnesses lasted from 1 to over 30 days, with a median of 7 days.

Nineteen cases were admitted to hospital. Eighty consulted their GP and of 65 cases interviewed in the case control and descriptive studies 36 went to the surgery, 10 were visited at home, and 19 were seen both in the surgery and at home. The GPs were consulted up to ten times, with a median of three. Twenty-two patients were prescribed medication. Of these, 16 were prescribed antibiotics.

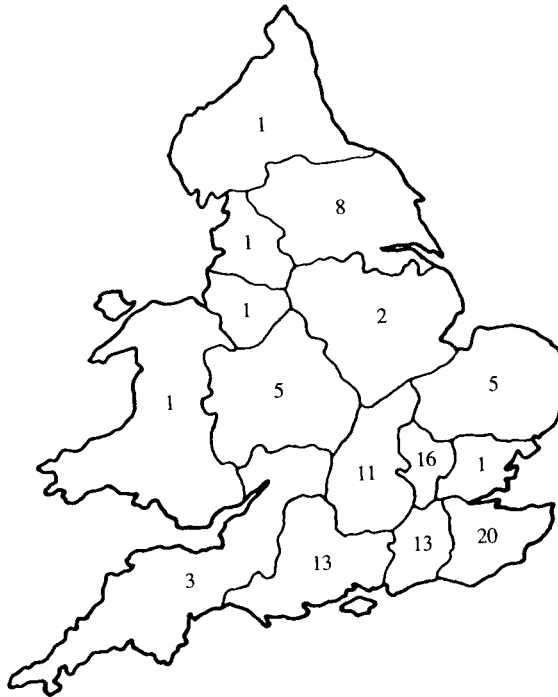


Fig. 2. Distribution of cases by NHS region ($n = 101$).

Case control study

Seventeen cases were interviewed for the case-control study of whom five were excluded as possible secondary cases. Nineteen matched controls were also interviewed. An association was found between infection and eating the German salami stick within 3 days, and within a week, of the onset of symptoms (Table 1). An exact probability test, taking into account the matched groups confirmed this association as highly significant (P value for consumption in the week before onset of symptoms = 0.0006, one tailed).

Microbiology

The salami sticks weighed 25 g and were 20 cm long and about 1 cm in diameter. Sixty-four sticks comprising samples from 11 different batches were examined over the weekend of Friday, 29 January. On Monday, 1 February *S. typhimurium* was isolated by the FHL from 5 of 10 sticks from one unopened batch and this isolate was confirmed by DEP the same day as DT 124. A further 13 samples including 7 from 2 new batches were examined before 3 February. *S. typhimurium* DT 124 was isolated from one of the new batches.

Extensive investigations carried out by the importers and manufacturers showed that contamination of the salami sticks with *S. typhimurium* DT 124 was confined to five consecutive batches which contained a single meat component in common. Physical and chemical analysis of contaminated and uncontaminated batches of product showed small but significant differences in pH and glucose

Table 1. Consumption of German salami stick in the week and in the 3 days before onset of illness

	Cases (n = 12)			Controls (n = 19)			Fisher 2-tailed exact tests
	Ate	Did not eat	Not sure	Ate	Did not eat	Not sure	
Within a week	10	0	2	2	16	1	0.00001
Within 3 days	7	3	2	1	18	0	0.0011

content (high in contaminated batches) and acetic acid concentration (low in contaminated batches) indicating that the strength of fermentation in contaminated batches was less than normal. Detailed investigations on the effect of starter cultures and glucono-D-lactone (GDL) on the destruction of *S. typhimurium* DT 124 were carried out using meat deliberately contaminated with this organism and made into salami using the factory process. The results failed to demonstrate any effect of these variables on the survival of salmonella during fermentation, drying, and subsequent storage, despite good acidification rates, and pH values of the salami falling to pH < 5.2 during manufacture.

There was a pronounced effect of temperature during storage on the survival of the salmonella in artificially contaminated salami sticks and at a temperature of 15 °C. Thus after 30 days at 25, 20 and 15 °C there was a five log reduction in numbers of *S. typhimurium* DT 124 cells, compared with day zero of storage, whereas at 10 °C the drop was only three logs, and at 5 °C, two logs. Similar differences were obtained with naturally contaminated salami stored at 5 °C and 20 °C. Refrigerated storage therefore prolongs the survival of salmonella.

Investigations carried out by the Bavarian health authorities and the importers confirmed the high standard of hygiene in the factory used for the manufacture of the salami sticks. Salmonella was not isolated from any of more than 200 samples taken from the factory. These included samples from raw materials, equipment, and the factory environment. Faecal samples taken from all workers in the factory were also negative for salmonella.

CONTROL MEASURES

On Monday, 1 February, on the basis of the epidemiological evidence, the manufacturers agreed to withdraw the salami sticks from sale in the UK. Shortly before the public were informed *S. typhimurium* DT 124 was cultured from the salami stick.

DISCUSSION

This is the first salmonella outbreak associated with a fermented meat product in the UK. The incident highlighted the value of a laboratory surveillance scheme which detected the episode at an early stage and led to immediate investigation and early intervention. Within a week of noting the increase in reported cases of *S. typhimurium* DT 124, preliminary and analytical investigations had identified

a source, the importers and manufacturers had been informed, the vehicle of infection removed from sale, the organism isolated from the product, and the public alerted.

The descriptive investigation added to our knowledge of *S. typhimurium* infection. Bloody diarrhoea was common compared with other outbreaks, or with sporadic cases of salmonellosis (5). Although no deaths were reported, the illness appeared to be severe as a high proportion of cases were admitted to hospital. Although the usual incubation period for salmonella infection is 6–72 h a feature of the outbreak was the number of primary cases with an incubation period between 3 and 7 days. Long incubation periods have been reported in other outbreaks of salmonellosis. An incubation period of 1 to more than 12 days has been documented in an outbreak of *Salmonella newport* infection in Sweden (4) and, in a recent outbreak of *Salmonella heidelberg* infection in the UK the incubation period was from 1 to 8 days (personal communication, Dr R. Stanwell-Smith). There are a number of possible explanations for the longer time period between ingestion of the vehicle and the onset of symptoms in the present outbreak. These include the high fat content of the product, which would both protect the organism in, and delay its passage through, the stomach. Ingestion of a low dose could be a partial explanation as well as the nature of the *S. typhimurium* serotype (personal communication, Dr Mair Thomas). The longer incubation period for salmonella infection has implications for the investigations of future outbreaks of salmonellosis as food histories may need to be obtained for at least the 7 days before the onset of symptoms.

Salami was associated with an outbreak of *S. newport* infection which affected 279 people in Australia in 1981 (6). In 1963 there was an incident in Italy due to *S. cholerae-suis* contaminated Italian dry salami (7). However, most food-poisoning outbreaks associated with fermented meats have been due to staphylococcal contamination (8–11) and have been reported from the USA.

Salami are coarse ground meat products which usually have a reduced pH as a result of fermentation by starter culture or microorganisms naturally present in the meat; most are dried to a moisture content of 40% or less. Process times may be as long as 100 days but can be as short as 7 days if the sticks have a small diameter. In the past it has been claimed (12, 13) that the manufacture of salami is difficult to standardize; however, salami is nowadays produced under closely controlled conditions by the major manufacturers.

Salmonella has been shown to survive for a longer period of fermentation and drying in meat mixtures in which a starter culture has not been used.

However, in the present investigation a major effect of fermentation on survival was not observed. The survival of salmonella from the beginning of fermentation to time of intended consumption has been documented (12). The meat used in the implicated salami stick consisted of 50% hog back-fat, and a combination of pork and beef, in addition to spices and curing salt. No starter culture was used in its fermentation. Because of its larger surface area to volume ratio, the drying time of the product was 6 days. The high fat content, in discrete fat pieces, was a characteristic of the sausage, and may well have contributed not only to survival of salmonella during processing and storage, but also during the organisms' passage through the stomach. The product was manufactured in Bavaria in the

Federal Republic of Germany and exported throughout Europe. Some 26 million of such salami sticks were imported into the UK in 1987. The salami stick was sold in individual nitrogen-filled, hermetically sealed foil envelopes, singly or in packs of five. Although the product has a shelf life of 6 months at ambient temperatures, supermarkets tended to display the product with other cold meats and salamis in chilled display cabinets, and purchasers often stored the product in their refrigerators. These practices contrast with those in the rest of Europe, where ambient temperature storage is the norm. This practice may have contributed to the survival of salmonella in the salami stick.

Although marketing was said by the importers not to be specifically targeted at children, it was of interest that most cases occurred in the under-sixteens. This could perhaps be explained by the convenience of the product for lunch-packs, and the recent trend towards sugar-free snacks for children. Most of the cases occurred in south-east England, probably because the importers had conducted a television advertising campaign in this region of the country in the weeks before Christmas.

However, a similar campaign was mounted in the Grampian region of Scotland, and although the Communicable Diseases (Scotland) Unit identified 20 isolates of *S. typhimurium* DT 124 in January and February 1988 (14) in 13 households where the salami snack had been eaten, the households were not clustered in the Grampian region.

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