

## The problems of tracing a geographically widespread outbreak of salmonellosis from a commonly eaten food: *Salmonella typhimurium* DT193 in North West England and North Wales in 1991

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### SUMMARY

Geographically widespread outbreaks involving commonly isolated organisms and where the vehicles of infection are commonly eaten foodstuffs pose particular difficulties at a technical and organizational level.

An outbreak of *Salmonella typhimurium* infection, affecting 39 people, spread over a wide area in North West England and North Wales in April and May 1991, was detected thanks to the practice of sending specimens to the national reference laboratory where phage typing and characterizing of antibiotic resistance patterns enabled the identification of a cluster of distinctive isolates (*S. typhimurium* DT193 resistant to sulphonamides, trimethoprim and furazolidone). An investigation, involving twenty environmental health departments in addition to health authorities and the Public Health Laboratory Service, showed an association between the illness and eating loose sliced cooked ham ( $P = 0.004$ ). Detailed tracing of the chain of supply of the ham showed this to be particularly cooked ham originating from a single small local producer ( $P = 0.00003$ ). Further investigation of that producer revealed that a batch of ham distributed on one day in early April was undercooked due to a malfunction in cooking equipment.

### INTRODUCTION

Three aspects of food poisoning outbreaks have previously been recognized as presenting particular difficulties in investigation. First, the pathogen may be commonly isolated so that cases may be identified that are, in truth, not

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associated with the outbreak and confound attempts to demonstrate epidemiological association with a common source. Secondly, the vehicle may be a commonly eaten food. Thus a history of eating the food may be equally prevalent in cases and controls, unless that history is qualified by more elaborate details of the brand or the time and place of purchase: details which study subjects will find more difficult to recall. Thirdly a relatively small number of cases may be spread over a large geographical area necessitating collaboration between a large number of agencies [1]. Thus outbreaks which are successfully investigated, particularly if the cases are geographically widespread, tend to be either of a commonly occurring isolate but an unusual food vehicle or an unusual isolate in a commonly consumed food [2, 3]. We describe an outbreak of foodborne salmonellosis where the organism was a commonly occurring serotype, the implicated foodstuff was an item which is commonly consumed, and the cases were scattered over a widespread area of North West England and North Wales.

#### THE OUTBREAK

An increase in the number of laboratory reports of human faecal isolates of *Salmonella typhimurium* definitive type (DT) 193 resistant to sulphonamides, trimethoprim and furazolidone was noted by Division of Enteric Pathogens (DEP) Central Public Health Laboratory at Colindale. Thirty-four cases initially were reported in the period mid April to early May 1991, throughout North West England and North Wales. These were the first isolates from humans reported in 1991 by DEP. In addition, only two food animal isolates had been made, one pig and one bovine. As this suggested a common source outbreak, an investigation was initiated on 20 May 1991.

#### METHODS

##### *Epidemiological*

Twelve out of 13 cases interviewed as a preliminary investigation had eaten cold cooked meat, particularly loose sliced ham. A case-control study was initiated to test the hypothesis that the consumption of loose sliced ham was associated with illness.

A case was defined as any person with a positive stool sample for *Salmonella typhimurium* DT193 resistant to sulphamethoxazole, trimethoprim and furazolidone identified by DEP in 1991. Cases already interviewed in the preliminary investigation were included. Three controls, matched for age (< 1 year, 1–4 years, 5–14 years, etc.) and sex, were randomly selected for each case from the list of their general practitioner. Controls with abdominal pain and diarrhoea in the last 2 weeks in April were excluded. Cases and controls were interviewed using a structured questionnaire and asked about their symptoms, travel abroad, and food consumption in the 3 days prior to onset of illness in the case. Details of retail outlets where cold cooked meats were purchased and food eaten outside the home were obtained. Cases and controls were interviewed over the telephone, or by home visits if this was not possible. Interviews were completed between 24 May and 6 June.

Analysis was carried out on Epi Info Version 5 [4] using a Mantel–Haenszel Summary  $\chi^2$  (equivalent to McNemar  $\chi^2$ , corrected).

#### *Environmental*

Environmental Health Departments traced the sources of ham from those outlets identified by cases or controls via suppliers back to the producers.

An implicated manufacturer was inspected by the local Environmental Health Department.

#### *Microbiological*

A sample of cooked ham was taken for microbiological examination from the implicated plant on 10 June 1991. None of the implicated batch of ham was available for testing.

### RESULTS

#### *Epidemiological*

##### *Descriptive epidemiology*

Of 39 cases ultimately identified by DEP between the beginning of April and 15 June 1991, 34, known to the investigating team at the time of the investigation, were interviewed.

Three cases lived in North Wales and the remainder lived in North West England. The cases were spread over 3 regional health authorities (RHAs), 13 district health authorities (DHAs), and 17 local authorities (LAs).

Their ages ranged from 9 months to 79 years, mean 30.6 years. Fifteen (44.1%) were male.

The earliest case became ill the day she returned from Spain on 5 April 1991. None of the other cases had travelled abroad. The remaining cases had onset dates between 8 April 1991 and 6 May 1991 (Fig. 1).

Thirty of 32 cases, from whom data on symptoms were obtained, had diarrhoea (1–50 times per day), 9 blood in the stool, 25 abdominal pain and 27 fever. Eleven required hospital admission. There were no deaths. The median duration of illness was 8 days (range 1–30 days), and the median duration of normal activity lost was 14 days (range 0–37 days).

##### *Case control study*

Two controls were obtained for each of 28 cases and 1 for each of 2 cases. No controls were obtained for 4 cases. Analysis was, therefore, based on 30 cases and 58 matched controls.

Cases were more likely than controls to have consumed ham (Odds ratio (OR) 3.5:  $P = 0.03$ ), particularly loose ham cut on the shop premises (OR 5.4:  $P = 0.004$ ) (Table 1). Detailed inquiry about the origin of the loose ham eaten by the 22 cases and 25 controls revealed that 14 of 30 cases compared to 2 of 58 controls had eaten loose ham that could be traced back to one named producer (OR for matched sets 17.3: 95% confidence intervals (CI) 2.3–131.6:  $P = 0.00003$ ).

Cases were also more likely to have eaten food prepared outside the home (OR 4.3: 95% CI 1.3–13.8:  $P = 0.02$ ). This association was independent of the association with ham.

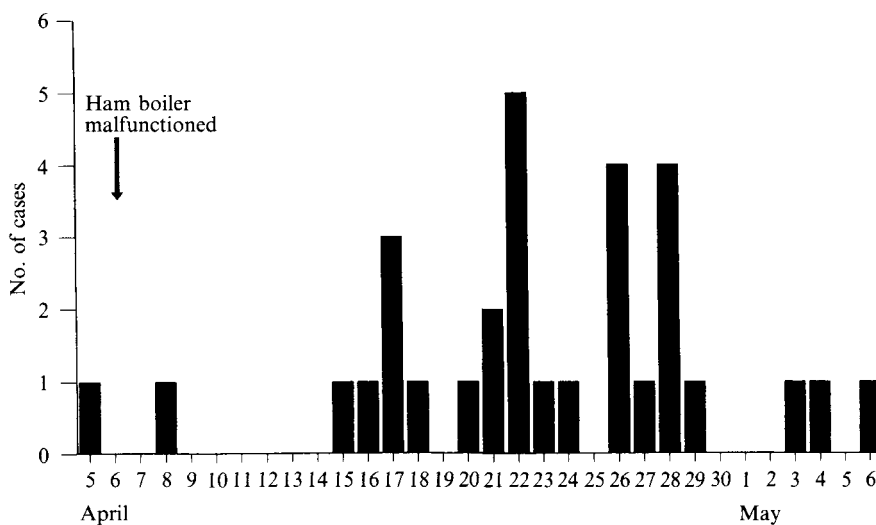


Fig. 1. Onset of symptoms in cases of *Salmonella typhimurium* DT193 in NW England and Wales – April–May 1991. The case with onset date 5 April became unwell on the day of return from Spain.

Table 1. *Food preferences*

Food	Cases ate/total	Controls ate/total	Odds ratio for matched sets	95% CI
Eggs	15/28	36/58	0.6	0.2–1.5
Mayonnaise	5/28	12/58	0.8	0.3–2.3
Ice cream	9/28	20/58	0.8	0.3–2.0
Unpast. milk	2/28	8/58	0.4	0.1–2.3
Yoghurt	12/30	27/58	0.8	0.3–2.0
Cup soup	3/30	5/58	1.2	0.3–5.0
Cold meat	27/30	40/58	4.7	1.0–21.4
Ham	25/30	33/58	3.5	1.2–10.4
Ham loose	22/30	25/58	5.4	1.6–19.0
Turkey	4/29	6/58	1.0	0.2–5.5
Beef	3/29	5/58	1.4	0.3–6.5
Chicken	4/29	3/58	2.4	0.3–12.6
Chicken	12/30	35/58	0.4	0.2–1.1
Meat pies	8/30	15/58	1.0	0.4–2.8
Saus. roll	2/30	10/58	0.3	0.1–1.8

#### *Environmental*

Environmental investigation involved the staff of 20 environmental health departments in following up 49 retail outlets, 18 suppliers, 15 producers of cooked meat and 7 suppliers of raw meat. Many of the retail outlets had bought ham from more than one supplier, and suppliers in turn were responsible for distributing meat from more than one producer.

The general environment of the plant implicated by the epidemiological investigation was satisfactory. The owner/manager revealed that on 5 April a malfunction of a heat probe had resulted in undercooking of hams. A single

affected batch of hams had been released for distribution as it appeared, on superficial inspection, to be cooked. No further batches were released until the probe had been repaired.

#### *Microbiological*

None of the implicated batch of ham was available for microbiological examination. Examination of a further sample of cooked ham from the plant showed a total count of  $2.6 \times 10^3$ . No coliforms, *Escherichia coli*, clostridia, staphylococci or salmonellae were found.

#### DISCUSSION

In reported outbreaks of salmonellosis in England and Wales the vehicle of infection was confirmed or suspected in less than 20% between 1986 and 1989 [5]. Typically, in geographically widespread outbreaks where investigation was successful, one of two circumstances occurred. Either the food vehicle was relatively unusual and distinctive as occurred in an incident caused by salami sticks contaminated with *Salmonella typhimurium* [2] or a frequently eaten food was contaminated with a rare serotype of salmonella. An example of the latter was an outbreak of *Salmonella ealing* traced to infant milk formula [3].

In this instance the practice in England and Wales of regularly forwarding salmonella isolates to the national reference laboratory allowed the commonly occurring *Salmonella typhimurium* to be more exactly identified. Phage typing identified the isolates as DT193 which is unfortunately the most commonly isolated phage type of *S. typhimurium* from humans in England and Wales. Further characterization using antibiograms showed that the outbreak isolates had an unusual pattern within this phage type. Thus it was the combination of phage typing and resistance typing which allowed the accurate identification of the cases and linked them to an outbreak. Should this practice of referring isolates become less common with changing organizational arrangements in the National Health Service outbreaks such as this one will be harder to identify. In Illinois, USA in 1985, where this practice was not standard, an outbreak of *S. typhimurium* was only linked with a failure of milk pasteurization after over 16000 culture confirmed cases had occurred [6].

By obtaining, with the co-operation of environmental health departments, details of the suppliers and producer of ham eaten by cases and controls, different subsets of that foodstuff could be identified. Ham, a food so commonly eaten that neither the cases nor the local investigators had reason to suspect it, was shown for most of the cases to have originated from a single small producer. This, in effect, characterized the ham eaten by the cases as unusual and distinctive.

The epidemiological evidence strongly implicated the ham from the single producer as the cause of the outbreak, and fulfilled many of the conventional criteria of causality [7]. Strength of association was demonstrated by an odds ratio of 17.3 for cases having consumed the suspect ham. The specificity of risk to exposure subcategories was clearly indicated by the odds ratio which was greater for loose ham than for all ham, and even greater for ham from one particular producer. The temporal relationship between exposure and onset of illness was

clearly demonstrated, the only case not fitting this pattern being the person who appeared to have contracted the illness abroad. The description of a specific defect in the cooking process provided collateral evidence in the chain of causality. Further support was provided by the identification, at the time, of *Salmonella typhimurium* DT193 in pigs in Yorkshire (A. Fleetwood, personal communication).

Not all cases recalled having eaten ham, and of those who had done so, it was not possible to trace all sources to the one producer. Possible explanations for this include consumption of the suspected ham outside the 3-day period prior to onset of illness, about which the investigation enquired. Further, inaccurate and incomplete recall of foods eaten or cross contamination of other cooked meat products may have occurred. Equally there may have been a second unidentified vehicle of infection. The supply network was complex and some contradictory information was given by different retail outlets and suppliers. Thus some links to the suspect producer were possibly not identified.

The producer in question was supplied with raw meat by five different suppliers, each in turn supplied by several other suppliers or abattoirs. Without conducting a widespread veterinary investigation it would not have been possible to implicate one animal source in this outbreak.

This particular incident turned out, fortunately, to be limited in extent. Nevertheless such incidents of salmonellosis need to be identified and investigated. This was demonstrated by a similar outbreak in North Wales in 1989, in which cooked meat was contaminated by *Salmonella typhimurium* DT12. The producer implicated was a similarly modest sized local operation. Nevertheless the outbreak resulted in illness in 640 individuals, 74 of whom were hospitalized, and 3 of whom died. The serious nature of this incident led to an internal review of the handling of the outbreak by the Welsh Office [8].

Without national surveillance, based on and including serotyping, phage typing and identifying antibiotic resistance patterns of salmonellae, this outbreak could not have been identified in the first place. Subsequent investigation would have been difficult at District Health Authority or Local Authority level, as cases were scattered over 3 regional health authorities, 13 district health authorities and 17 local authorities; the numbers of cases in any one district were small. Consultants in Communicable Disease Control are now being established at district level. However, as this outbreak demonstrates, there are times when both the recognition and subsequent investigation of infectious disease outbreaks has to be undertaken from a broader geographical base.

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