Large outbreak of food poisoning caused by *Salmonella typhimurium* definitive type 49 in mayonnaise

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Abstract

An investigation was conducted to determine the vehicle of infection of an outbreak of food poisoning in a large metropolitan building early in 1988. A questionnaire was distributed to 700 people who had eaten in the building during the week of the outbreak, and attack rates for specific foods were calculated. Food and stool samples, environmental samples, and eggs and environmental swabs from the egg suppliers were examined microbiologically. Altogether 474 questionnaires were returned, 120 people reporting gastrointestinal illness. The illness was significantly associated with foods containing mayonnaise. *Salmonella typhimurium* definitive type 49 was isolated from 76 of the 84 stool samples containing salmonella and from five of the eight samples taken from the chicken house of the main egg supplier.

Mayonnaise was probably the vehicle of infection, which was caused by *S typhimurium* definitive type 49.

Introduction

From 1983 to 1987 the Public Health Laboratory Service (PHLS) Communicable Disease Surveillance Centre received an average of 6035 laboratory reports of *Salmonella typhimurium* infections in humans. *S typhimurium* definitive type 49 was the most commonly reported phage type. This phage type is also found in cattle, poultry, pigs, and sheep (PHLS Communicable Disease Surveillance Centre, unpublished data). The organism is frequently associated with outbreaks of food poisoning and in 1985 was implicated in 153 outbreaks among the general public and in families. We describe a large outbreak of food poisoning caused by *S typhimurium* definitive type 49 associated with mayonnaise.

Background

Early in 1988 one of us (DGC) was notified of an outbreak of food poisoning among people working in a large metropolitan building. There were also reports that guests who had attended two private functions in the building were affected. The next day salmonella was isolated from each of the stool samples from five people who had eaten in the building. One isolate was examined in the PHLS Division of Enteric Pathogens and was identified as *S typhimurium* definitive type 49.

The building had a dining room and a staff canteen, and private functions were held in a separate reception room. Twenty three people who reported a gastrointestinal illness were interviewed. Most had eaten in the dining room a week before, on the Thursday. Thirteen of the 43 catering staff who were interviewed had similar symptoms. Four administrative staff who

ate in the staff canteen were reported to have been ill. The information obtained from the preliminary reports and interviews suggested that meals eaten on that Thursday were probably associated with the outbreak of salmonella infection. Later illness was reported in guests after a reception held the next day (Friday). An investigation was carried out to describe the extent of the outbreak, determine the vehicle of infection, and implement control measures.

Methods

We defined a case as any person who had diarrhoea or vomiting and had eaten in the building and selected three cohorts for an analytical study. A self completed questionnaire was distributed to those who had eaten lunch or dinner in the dining room and to guests who had attended either a private lunch or a cocktail party on the Thursday. Information was requested on symptoms and foods eaten, and attack rates for specific foods were calculated. The statistical tests used were χ^2 with Yates's correction, Fisher's exact two tailed test, and Cochran's test. Guests and administrative staff who reported a gastrointestinal illness and had eaten in the building on the Friday, as well as all the catering staff, were interviewed. The kitchen was inspected and the methods of preparing and storing foods were investigated. Food and water samples as well as environmental swabs were taken for microbiological examination, and all members of the catering staff were asked to provide a stool specimen. Eggs and environmental samples were obtained from the premises of three egg suppliers. The salmonellas that were isolated were sent to the Division of Enteric Pathogens for phage typing and determination of the plasmid profile.

Results

A total of 474 out of 700 people returned completed questionnaires. Altogether 120 people, 85 men and 35 women, reported a gastrointestinal illness after eating in the building on the Thursday. The ages of those affected were between 22 and 83 years. The incubation period was between six hours and nine days (table I). Diarrhoea was the main symptom and was reported in 111 cases, blood being noted in the stools of nine of them. Ninety eight people had abdominal pain, 88 were feverish, the temperatures reported being between 37.2°C and 40°C, and 33 complained of vomiting. Forty six consulted their family doctor and three were admitted to hospital. Among those who had eaten in the dining room there was a significant association between cases of salmonella food poisoning and eating dinner on the Thursday ($p=0.00001$). Of the foods served at this meal, Waldorf salad, lettuce, and drinking water from jugs on the table were

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TABLE 1—Day of onset of gastrointestinal illness in 114 out of 120 cases whose day of onset was known

	Day of onset of symptoms*									
	1	2	3	4	5	6	7	8	9	10
No of cases	2	45	37	11	5	6	3	4		1

*Day 1 = Thursday.

associated with illness. In addition, when foods that contained mayonnaise were analysed as a single group a significant association was seen with illness (table II). Port was the only drink or food associated with illness in the guests who attended the private lunch party ($p=0.03$). Among guests who attended the cocktail party five foods were associated with illness: glazed smoked salmon canapés, curried half eggs, taramasalata, scampi, and chipolatas (table III).

Sixteen of the 74 guests who attended a private dinner on the Friday reported a gastrointestinal illness. There was no choice of foods available at the dinner. It was possible to interview seven guests and their onsets of symptoms were on the Saturday and Sunday. Four administrative staff were interviewed. Two became ill after eating lunch on the Friday in the staff canteen and both had eaten coleslaw; the illnesses in the two other members of the administrative staff were unrelated to eating in the building. Thirty three of the 92 catering staff reported a gastrointestinal illness during the same period.

MICROBIOLOGY

In 84 people salmonella was isolated from faecal specimens: 32 people worked in the building and had eaten in the dining room, 36 were catering staff, two were administrative staff, and 14 were guests who attended one of the three private functions on the Thursday and Friday. The Division of Enteric Pathogens confirmed 76 salmonella isolates as *S typhimurium* definitive type 49 with a previously unrecognised plasmid profile. *S typhimurium* definitive type 49 with the same plasmid profile as the outbreak strain was cultured by means of pre-enrichment from tartare sauce which had been made from the mayonnaise made on the Wednesday. The pH of the tartare sauce was 3.6.

S typhimurium definitive type 49 was isolated from five of the eight samples of poultry droppings taken from the chicken house of the main egg supplier. In two of these isolates the plasmid profile was identical with that found in the patients' stools and the tartare

sauce. The three other isolates had a different profile. *S typhimurium* of different phage types were isolated from environmental samples taken from the two other egg suppliers. No pathogenic organisms were isolated from environmental swabs or from the remaining food and water samples. Apart from the tartare sauce, however, no food remained from the week in question. *S typhimurium* definitive type 49 with the outbreak plasmid profile was cultured from the stools of a patient who was not connected with this outbreak but regularly ate raw eggs obtained from the main egg supplier.

ENVIRONMENTAL FACTORS

The building had one kitchen, which provided 500 meals each day. The preparation and cooking areas were limited and at times it was not possible for raw and cooked foods to be separated adequately. There was insufficient cold storage space, and raw meat and foods such as mayonnaise were kept in the same refrigerator.

Mayonnaise, made from fresh egg yolks, oil, and vinegar, was prepared by staff two to three times a week. At the end of each day unused mayonnaise from serving dishes was returned to the kitchen, where it was sometimes mixed with a new batch of mayonnaise. The eggs were usually supplied by one producer. On the Tuesday, however, eggs were obtained from two other farms. Mayonnaise prepared on the Wednesday was used in Waldorf salad, coleslaw, salmon cornets with cucumber mousse, curried half eggs, and various other foods. In addition, it was served in the dining rooms and formed a base for tartare and prawn cocktail sauces. The remaining egg whites were stored and later used to bind raw minced chicken stuffing for the lamb en croute, which was served at the private dinner on the Friday. Plastic and nylon piping bags were used for egg and mayonnaise mixtures as well as cucumber mousse and taramasalata. The bags were cleaned between the preparation of different dishes by washing and soaking in a hypochlorite solution.

CONTROL MEASURES

The kitchens remained open but were thoroughly cleaned and disinfected with hypochlorite. Catering staff with symptoms were excluded from work. Menus were reviewed and foods known from past experience to have been associated with a high risk of salmonella infection were removed. These included aspic and home made mayonnaise as well as patés and cold meats that had not been cooked in the kitchen.

Discussion

The epidemiological investigations showed that infection with *S typhimurium* definitive type 49 was associated with meals eaten on the Thursday and Friday. Although the findings among the affected groups and guests at the cocktail party suggested that several foods were associated with infection, many foods had mayonnaise as the common ingredient—namely, Waldorf salad, coleslaw, curried half eggs, and scampi, which was served with tartare sauce. Mayonnaise also was used for the salmon cornet with cucumber mousse at the private lunch and was the probable vehicle of infection, although a statistical association was not proved because nearly all the guests had eaten this food. Taramasalata did not have a mayonnaise base but may have been contaminated by inadequately cleaned piping bags that had been used for the curried half eggs.

The isolation of the outbreak strain of salmonella from the tartare sauce also implicated mayonnaise as the vehicle of infection. The method of storing and reusing leftover mayonnaise at the end of each day provided the opportunity to contaminate subsequent

TABLE II—Attack rates specific to different foods eaten at dinner on Thursday. Values are numbers of people (n=63)

Food	Those who ate			Those who did not eat			Yates's corrected p value†
	Ill	Not ill	Total*	Ill	Not ill	Total*	
Jacket potato	7	17	24	19	11	30	0.03
Waldorf salad	9	2	11	12	20	32	0.03
Lettuce salad	14	4	18	11	16	27	0.03
Water from jugs	25	6	31	7	14	21	0.002
Foods containing mayonnaise grouped together	25	11	36	3	8	11	0.03‡

*Excluding those who were unsure of their consumption of the relevant item.

†Significant associations only.

‡Fisher's two tailed exact test.

TABLE III—Attack rates specific to different foods eaten at private cocktail party on Thursday. Values are numbers of people (n=101)

Food	Those who ate			Those who did not eat			Yates's corrected p value†
	Ill	Not ill	Total*	Ill	Not ill	Total*	
Smoked salmon canapés	22	27	49	8	31	39	0.03
Curried half eggs	19	11	30	10	53	63	0.00001
Taramasalata	17	12	29	13	46	59	0.002
Scampi	23	25	48	9	39	48	0.005
Chipolatas	25	34	59	6	31	37	0.015

*Excluding those who were unsure of their consumption of the relevant item.

†Significant associations only.

batches. The source of the infection was probably contaminated eggs bought from the main producer as *S typhimurium* definitive type 49 of the type found in the outbreak was isolated from samples of hen droppings taken from the egg farm. In addition, the same strain was cultured from the stools of a patient who was not connected with this outbreak but regularly ate raw eggs from that farm. This association between salmonella infection and the consumption of foods containing raw egg products suggests that the likely vehicle of infection at the private dinner on the Friday was the egg white used in the lamb en croute stuffing.

Although water served at dinner on the Thursday seemed to be associated with this illness, it was probably not the vehicle of infection as most of those who drank water also ate a food containing mayonnaise. Furthermore, water was not linked to illness in the other groups that were investigated. We could not establish an independent association between the illness and drinking water at dinner on Thursday or eating chipolatas at the cocktail party as the numbers were too small. Chipolatas may, however, have been linked to infection owing to cross contamination. Port was unlikely to have been a vehicle of infection as salmonellas could not survive in this fluid and only six people who were ill had this drink.

Mayonnaise has been associated with earlier outbreaks of salmonellosis. Ten thousand cases occurred in Denmark in 1955 and were caused by the consumption of a commercially prepared product, and a home made mayonnaise was reported to have caused a second but much smaller outbreak affecting 41 people, of whom two died.¹ Mayonnaise was also associated with a large outbreak of salmonella food poisoning among passengers on flights between the Canary Islands and Helsinki. There were many hundreds of cases and six deaths. *S typhimurium* was isolated in several cases, from one food handler, and from mayonnaise.² In 1986 a hospital outbreak of *S typhimurium* definitive type 197 was associated with a product based on mayonnaise: 82 hospital staff were affected and the organism was isolated from tartare sauce.³ Although the vehicles of transmission in these outbreaks were mayonnaise and tartare sauce, the sources of infection were not documented. In the present outbreak the acidity of the tartare sauce was interesting as most organisms are unable to survive at a pH lower than 4.1.⁴

In the United Kingdom eggs have been implicated in five recent outbreaks of *S typhimurium* definitive type 141 (PHLS Communicable Disease Surveillance Centre, unpublished datas.) The organism was

cultured from three foods made with raw shell eggs (eggs taken from their shells) in one outbreak and was also grown from samples of bulk eggs from five of the 11 farms that supplied the egg distributor. Salmonellas were not, however, isolated from 1000 shell eggs from these farms. In the United States after an outbreak associated with eggnog only three of the 1117 eggs examined yielded *S typhimurium*.⁴

These and other studies suggest that the rate of contamination of eggs in infected flocks may be extremely low. In our study *S typhimurium* definitive type 49 was isolated from samples of hen droppings but not from shell eggs or bulk egg. In the previously reported outbreaks due to mayonnaise a link with a particular egg producer was not shown. This report shows that it may be more profitable to examine environmental samples from chicken farms, such as droppings or dust, rather than eggs. In addition, in our study the analysis of plasmid profiles proved invaluable in identifying a specific variant within a common phage type.

An association between foods made with shell eggs and another salmonella serotype, *S enteritidis*, has recently been reported in the United Kingdom and in the United States.^{5,6} Because of this the Department of Health and Social Security recommended that food manufacturers and caterers should use pasteurised liquid egg rather than shell eggs in uncooked dishes and made recommendations about the handling of shell eggs.⁷

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ANY QUESTIONS

Are there any medical hazards to occupants of vehicles with airconditioning units?

The potential health hazards of airconditioning systems in buildings have been widely discussed. The systems may use equipment containing stagnant water, and if this is colonised by micro-organisms and they or their breakdown products become airborne illnesses such as legionnaires' disease and humidifier fever may result.

Airconditioning systems in motor vehicles differ from those in buildings in one important way: they do not contain water. They are simply refrigeration units, attached to the engine bulkhead to cool the indrawn air. The coolant is a fluorocarbon, usually dichlorodifluoromethane (CCl₂F₂). This compound has been shown to cause dizziness when inhaled as a 5% concentration in air and unconsciousness at 15%.¹ These concentrations are equivalent to 50 000 and 150 000 ppm respectively: the current United Kingdom occupational exposure limit is 1000 ppm for eight hours and 1250 ppm for 10 minutes.² The compound has also been implicated as a cause of cardiac arrhythmia and arrest, particularly in states

of anger and excitement associated with high circulating adrenaline concentrations. Such states may (as we well know) arise while driving. Thus leakage of the refrigerant into the passenger compartment could pose a risk to health, although I have never seen such a case reported. If dichlorodifluoromethane is exposed to hot metal or flame it will decompose, producing highly toxic gases, such as hydrogen fluoride and hydrogen chloride.³ These dangerous compounds could, therefore, be produced as the result of collision or fire. In reality it is much more likely that injury or death would result from trauma or burns.

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