Epidem. Inf. (1989), **103**, 425–433
Printed in Great Britain

A large outbreak of *Salmonella enteritidis* phage type 4 associated with eggs from overseas

A. STEVENS[1], C. JOSEPH[2], J. BRUCE[2], D. FENTON[3], M. O'MAHONY[2], D. CUNNINGHAM[3], B. O'CONNOR[3] AND B. ROWE[4]

[1] *Parkside Health Authority*, [2] *PHLS Communicable Disease Surveillance Centre*, [3] *City of Westminster Department of Environmental Services*, [4] *PHLS Division of Enteric Pathogens*

(*Accepted 8 July 1989*)

SUMMARY

In February 1989 the largest reported outbreak to date in the United Kingdom of *Salmonella enteritidis* phage type 4 (PT4) infection occurred following a wedding reception at a hotel. One hundred and seventy-three people met the case definition of illness of whom 118 had the organism isolated from their stools. A further 17 were found to be *S. enteritidis* PT4 positive, but were asymptomatic. Lightly-cooked, egg-based sauces were the epidemiologically proven vehicles of infection. Investigations showed this outbreak to be the first to implicate imported European eggs as the source of infection. An unusual feature of this outbreak was a reported incubation period of less than 3 h for some of the confirmed cases of salmonellosis.

INTRODUCTION

Human isolates of *Salmonella enteritidis* phage type 4 (PT4) identified by the Public Health Laboratory Service (PHLS) Division of Enteric Pathogens (DEP) have increased dramatically in the years 1981–8, from 392 to 12522. Outbreaks of *S. enteritidis* PT4 associated with the consumption of eggs or egg products have also risen, particularly between 1987 and 1988. This paper describes such an outbreak which for the first time involved eggs from overseas.

BACKGROUND

On Tuesday, 7 February 1989 the City of Westminster Department of Environmental Services (DES) received information concerning a possible outbreak of food poisoning associated with a wedding reception. It was contacted separately by the manager of the caterers, officers from the Environmental Health Departments in three local Boroughs and the Health and Safety Consultant for the hotel who reported 30 people with symptoms of food poisoning who had

Address for correspondence: Dr A. Stevens, Department of Public Health, Mint Wing, Centre Building, St Mary's Hospital, Praed Street, London W2.

attended the wedding. An action committee was formed by the DES to investigate the extent of the outbreak and vehicle of infection, as well as to implement control measures to prevent further spread of infection.

The wedding reception was held at a London hotel on Sunday 5 February. All of the food except the wedding cake which came from an independent baker, was supplied, prepared, delivered and served by outside caterers specializing in kosher food. The meal consisted of milk and fish items which were served at a buffet reception and luncheon.

Two hundred and sixty-seven guests attended the wedding function. Fifty-seven staff from the catering firm, comprising 18 food preparers, 32 servers and 7 others were employed for the function as well as 15 hotel staff who served drinks.

An immediate inspection of the premises of the hotel and of the caterers was made and food details collected.

METHODS

Descriptive and analytical epidemiology

Three cohorts of people were investigated: the wedding guests, the caterers who prepared and served the food and the hotel wine waiters who served the drinks. A number of telephone interviews with sick guests were made to establish the precise symptoms of the illness. Among the guests and wine waiters a case was defined as any person who developed symptoms of *either* diarrhoea (three or more loose stools within 24 h), *or* fever together with nausea, abdominal pain and/or vomiting on or after the day of the wedding reception. The case definition for caterers was any person taking part in the preparation or serving of food at the wedding who developed similar symptoms from 1 week before the reception, in order to identify a possible source of infection from a food handler.

Three self-administered questionnaires were prepared, one for each of the cohort groups. The questionnaires asked about age and sex as well as the timing, nature and severity of symptoms for descriptive epidemiological purposes. For the analytical study it requested specific details of the food and drink consumed at both the buffet reception and the luncheon. In addition to the questions asked on the guest questionnaire, the catering staff were asked which parts of the meal they helped to prepare or serve. The wine waiters were asked to specify their duties at the wedding function in addition to the other questions.

The null hypothesis for the cohort studies was that there was no difference in the consumption of individual foods and drinks between cases and those who remained well and who had no microbiological evidence of infection.

Data analysis was carried out using 'Epi-info' software (1). Food-specific attack rates were calculated using Yates' corrected chi-squared test, or Fisher's exact two-tailed test for small numbers and Cochran's test for independence. Sixteen guests and one caterer who were asymptomatic but who had *S. enteritidis* PT4 isolated from their stools and four people with symptoms not meeting the case definition were excluded from the analyses.

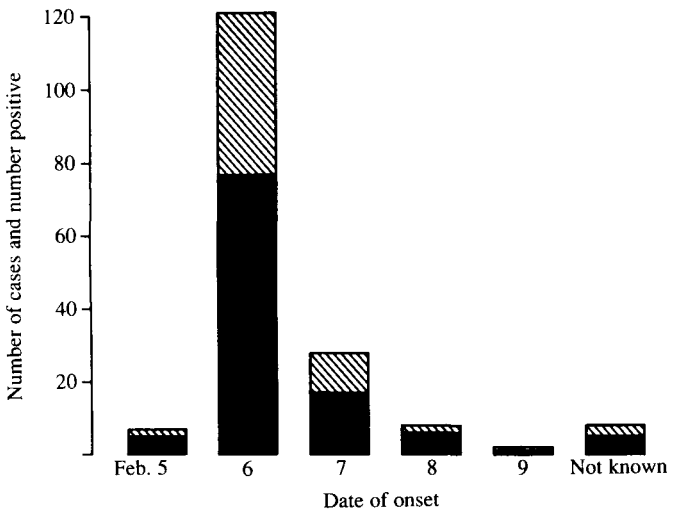

Fig. 1. Date of onset of symptoms in the total ill (▨) and the number positive (■) for *S. enteritidis* phage-type 4.

Microbiology

A general microbiological screen was performed on stool specimens obtained where possible from wedding guests who reported gastrointestinal symptoms as well as from catering staff and wine waiters. Isolates of salmonella were then forwarded to the PHLS DEP for serotyping and phage typing.

The remaining eggs from the batch used (approximately 950) were collected from the caterers premises and distributed to the PHLS laboratories at Dulwich, Exeter, Hull, Leeds and Preston for analysis using the PHLS method for examination of egg shells and contents (2). There were no food samples left over from the wedding.

Environment

Environmental Health Officers investigated the premises of the caterers and their food transport facilities and those parts of the hotel used for the function, as well as the sources, methods of preparation, storage and transport of the food. The wedding cake and baker were also investigated.

RESULTS

Descriptive epidemiology

Completed questionnaires were returned from 249 (93%) of the 267 guests, 32 (56%) of the 57 catering staff and 11 (73%) of the 15 wine waiters. A total of 165 (66%) guests, 4 (12·5%) catering staff and 4 (36%) wine waiters reported a gastrointestinal illness which fitted the case definition. The epidemic curve showed that most of the cases (70%) became ill the day after the wedding (Fig. 1). The incubation period ranged from 2·5 to 84 h, median 25 h, and the duration of illness

https://doi.org/10.1017/S095026880003082X Published online by Cambridge University Press

Table 1. *Frequency of symptoms in cases in the three cohorts*

Symptom	Guests ($n = 249$)	Catering staff ($n = 57$)	Wine waiters ($n = 15$)
Diarrhoea*	150	4	4
Blood in stools	10	1	—
Vomiting	41	2	1
Abdominal pain	146	3	3
Nausea	113	2	1
Feeling feverish	129	1	3
Muscle pain	110	2	3
Headache	37	1	1

*Three or more loose stools in 24 h.

from 1 to 15 days, median 4 days. The date of onset of symptoms for three of the catering staff was the day following the wedding reception with an incubation period which ranged from 18 to 33 h. The date of onset of symptoms and length of illness was not recorded in the questionnaire returned by the fourth member of the catering staff who reported an illness. Three of the four wine waiters who were affected were ill between 18 and 45 h after the wedding luncheon; one did not record when his symptoms began.

There were no significant differences in attack rates between men and women and between sex or age groups except for children under 15, of whom all but one were unaffected ($P = 0{\cdot}004$). The main symptoms of illness in the cases were diarrhoea, abdominal pain, fever, nausea and muscle pain; vomiting was relatively uncommon (Table 1). Although no specific information was requested on headaches, it was reported by 22% of the cases. Four people had symptoms but did not meet the case definition. Of the guests, 94 consulted their General Practitioners (GPs), four cases visited a hospital outpatient department and a further three were admitted to hospital. Three of the four catering staff who were ill visited their GP and one person was admitted to hospital. Two of the four ill wine waiters visited a hospital outpatients' department and one saw his GP but none was admitted to hospital.

Analytical epidemiology

Overall attendance at both the champagne reception and the main meal was examined and showed an association only between illness and the main meal ($P = 0{\cdot}000006$). However, there was an association found with the consumption of tartare sauce served at the champagne reception. None of the nine people who did not attend the main meal was ill. Apart from the association with the consumption of tartare sauce, illness amongst wedding guests was significantly associated with hollandaise sauce, bottled mineral water, salmon en croûte, champagne sauce, pasta shells, croquette potatoes and strawberries at the main meal (Table 2). Cochran's test for risk associated with all these items showed that consumption of salmon en croûte and champagne sauce were risk factors independent of the others. Bottled mineral water was apparently an independent risk factor but of the people who drank it, all but two had eaten salmon en croûte and/or champagne sauce and these two were not ill; these small numbers invalidate this

Table 2. *Food-specific attack rates in the wedding guests*

	Consumed			Not consumed			Yates' corrected
	Case	Not case	% Case	Case	Not case	% Case	*P* value
Champagne reception							
Tartare sauce	75	17	81	81	42	66	0·02
Main meal							
Hollandaise sauce	147	39	79	15	15	50	0·001
Mineral water	102	21	83	58	29	67	0·01
Salmon en croûte	164	45	78	1	9	10	0·00003*
Champagne sauce	146	30	83	11	17	39	0·000001
Pasta†	1	5	17	161	49	77	0·008*
Croquette potatoes	149	41	78	13	13	50	0·004
Strawberries	109	26	81	53	27	67	0·03

* Fisher's exact two-tailed test.
† Protective effect.

statistical finding. Altogether, 146 (88%) of the cases in the guest cohort ate both salmon en croûte and champagne sauce, 10 cases had salmon en croûte only, 8 were unsure of champagne sauce but definitely had salmon en croûte, and 1 had neither. Pasta shells and tomato sauce were found to be a protective factor. This dish was served to children only.

No food was shown to be associated with illness among the catering staff. Among the cohort of wine waiters, consumption of asparagus and hollandaise sauce were found to be significantly associated with illness. These were not tested for independence since they were served together and both were eaten by all four cases. None of these cases ate salmon en croûte or champagne sauce.

Microbiology

Salmonella enteritidis PT4 was isolated from 128 guests, 3 catering staff and 3 wine waiters. No other pathogens were found. One of the 17 people who was asymptomatic but positive for *S. enteritidis* PT4 was a caterer, but he was not involved in the breaking of the eggs or in the preparation of the egg based sauces. All of 950 eggs tested microbiologically from the batch used for the wedding were negative for *S. enteritidis*, although *S. typhimurium* DT 10 was cultured from one egg shell.

Environment

At both the caterers and in their transport facilities, there was full compliance with food hygiene regulations (2); the standards of hygiene, temperature control and food storage were satisfactory.

The menu included extensive use of fresh eggs, all imported from Denmark. These were believed by the caterers to be salmonella free and used for that reason. Two batches of eggs were broken into separate containers. One batch of 360 eggs was used for the savoury dishes of hollandaise sauce, champagne sauce, goujons of whiting, deep-fried mushrooms, salmon en croûte, fillets of plaice, and croquette potatoes. The eggs were cracked, separated into yolks and whites the evening

before the function and were left in the refrigerated van overnight. Cooking temperatures for the hollandaise and champagne sauces, which were made separately at the hotel, were said to have been 50–55 °C. All other egg dishes including the desserts, used the second batch of 360 eggs and were said to have been cooked at 80 °C or more. They were prepared at the caterers premises.

Standards at the hotel were good. The kitchen had been steam cleaned and all surfaces covered with aluminium foil prior to use by the outside caterers. However no food preparation was undertaken there except by the catering staff using their own equipment.

The baker who made the wedding cake reported that he used frozen pasteurized eggs in its preparation.

CONTROL MEASURES

All the food preparers, including those without gastrointestinal symptoms were screened for evidence of salmonella infection. All food preparers and wine waiters who had symptoms or who were salmonella positive were excluded from work until three negative stools had been obtained or until they were otherwise instructed by their Medical Officer for Environmental Health. The caterers were instructed to avoid the use of uncooked eggs in finished food products. The Danish State Serum Institute and Veterinary Service were both informed of the outbreak. It was acknowledged that a high proportion of the Danish poultry population was infected with salmonella (mainly *S. typhimurium*) and that several small outbreaks, with eggs the suspected vehicle of infection, had occurred in the last few years (Dr H. Zoffman and Dr K. Gaarslev, State Serum Institute Copenhagen, personal communication).

DISCUSSION

This outbreak has been the largest outbreak of *S. enteritidis* PT4 so far reported in the United Kingdom. It is also the first known outbreak where imported eggs from the Continent have been the source of infection. The eggs were specially imported in an attempt to circumvent Government guidelines warning of the risks in using home-produced fresh shell eggs in catering. This was to accommodate a religious practice which necessitated their use in egg-based dishes.

Epidemiological investigation implicated lightly cooked egg-based sauces as the vehicle of infection and not a food-handler source. The catering staff who were ill were found to have become ill at the same time as the wedding guests and were therefore unlikely to have been responsible for causing the outbreak. The association between illness and the food items implicated other than the egg dishes served at the wedding function was almost certainly the result of there being a limited choice of menu and a high attack rate among those who ate these particular foods (Table 2). The large number of people who drank bottled mineral water could possibly be related to either the taste or saltiness of the salmon and champagne sauce. Bottled mineral water has no known association with salmonella infection.

The very short incubation period reported by some of the guests is an interesting finding. Altogether, seven guests reported becoming ill on the same day

as the wedding, three within 3 h of consuming the main meal, all of whom were found to be positive for *S. enteritidis* PT4. This unusual observation is difficult to explain in view of the known pathogenicity of salmonella infection. Two of the three guests who were ill within 3 h reported vomiting as their first symptom; this might have been due to the ingestion of large amounts of endotoxin in the contaminated food.

The outbreak occurred against a background of increasing reports of *S. enteritidis* to CDSC and the publicity relating food poisoning with the consumption of fresh shell eggs. Outbreaks of salmonellosis associated with eggs or egg products have increased dramatically since 1987. In 1987 six outbreaks associated with eggs were reported through the formal laboratory reporting system and none were due to *S. enteritidis* PT4; but in 1988 34 outbreaks known to be associated with eggs were reported from this system with a further 26 outbreaks ascertained from other data sources. Of these 60 egg associated outbreaks, 34 were due to *S. enteritidis* PT4. The cumulative total of sporadic cases of *S. enteritidis* PT4 identified by DEP from isolates from laboratories in 1989 shows a twofold increase compared with the same period in 1988 (PHLS, DEP unpublished data).

Imported eggs from Europe as a vehicle of infection is a new phenomenon in the UK although *S. enteritidis* has been recognized as a problem in some parts of Europe for several years with infections reported in the UK in travellers returning most notably from Spain and Portugal (4–6). In the summer of 1988 an outbreak occurred at a hotel in Madeira where lightly cooked eggs were implicated as the vehicle of infection and *S. enteritidis* PT4 the causative organism (PHLS, CDSC unpublished data). Three outbreaks associated with the use of raw eggs in mayonnaise have been documented in Denmark. In one in 1955, 10000 people were infected with salmonellosis from commercially prepared mayonnaise (7). No further cases of salmonella infection have been reported in Denmark from commercially prepared mayonnaise since recommendations on preparation procedures were circulated by the Danish Administration. The other two outbreaks in the early 1960s which involved raw eggs originated from large kitchens in Denmark. In one, 41 out of 42 people were ill and two died following a lunch party (8), and in the other, *S. typhimurium* was isolated from the cases and from the mayonnaise (9). The most recent published *S. enteritidis* (not phage typed) outbreak in Denmark was in 1980 from a day nursery (10).

Danish eggs were used by the wedding caterers apparently having been advised by their wholesalers that they were salmonella free, and that they would avoid the known risk of illness from home-produced eggs. The caterers were aware of the government's health warnings on eating raw or lightly cooked eggs (11) and had been sent information from Westminster DES setting out guidelines and recommendations on the use of eggs in catering (12). The continued use of fresh shell eggs by the caterers was necessitated by a religious practice which required each egg to be broken open and inspected by a rabbi before use. However once broken, the eggs were separated with the yolks stored together in large numbers, as were the whites of the eggs. The time taken to break each large batch of eggs and the period of time required for cooling them down during refrigeration would allow any contamination from an infected egg to spread into the rest of each batch.

This outbreak has highlighted the risk of food poisoning from imported European eggs, although the level of egg contamination in the different European countries is unknown. The fact that over 900 Danish eggs were tested for *S. enteritidis* following the UK food poisoning incident and found to be negative suggests the contamination rate is low. Although it is consistent with British studies which have found a level of contamination in the order of 1 in 15000 eggs in samples not associated with outbreaks (Ministry of Agriculture Fisheries and Food, 5 May 1989, unpublished data) and 1 in 1000 eggs from sources suspected of being associated with human infection (13), it is at odds with some studies which have shown that eggs examined in connection with an outbreak can contain a significant proportion of positives (14, 15).

Despite the low risk of an individual egg being contaminated, this episode highlights the magnification of the risk when catering practices involve mixing large numbers of eggs together. It has also demonstrated the imprudence of overriding government and environmental health advice. If, because of a religious law only fresh shell eggs can be used, perhaps menus for large functions should exclude their use altogether until the salmonella problem in eggs has been solved.*

ACKNOWLEDGEMENTS

We wish to thank Dr C. Boyd-Scobie, Dr R. Beardow and Dr S. Mawer for their help and also Ms C. Martin and all the other environmental health officers, mainly from the London Boroughs of Barnet, Enfield, Redbridge, Westminster and Hertsmere who assisted in the investigation of this outbreak. We also thank the Public Health and Hospital laboratories for their microbiological help, Mr J. C. Bell at the Ministry of Agriculture, Fisheries and Food and Drs H. Zoffman and K. Gaarslev of the State Serum Institute, Copenhagen.

REFERENCES

1. Epidemiological Programme Office. Centre for Disease Control, Atlanta GA 30333.
2. Mawer SL, Spain GE, Rowe B. *Salmonella enteritidis* phage type 4 and hens' eggs. Lancet 1989; i: 280–1.
3. MAFF and DHSS 1970; Food Hygiene (General Regulations) SI No. 1172 London: HMSO.
4. Anonymous. Foodborne disease surveillance in England and Wales 1984. Br Med J 1986; **293**: 1424–7.
5. Perales I, Audicana A. *Salmonella enteritidis* and eggs. Lancet 1988; ii: 1133.
6. Sharp JC. Salmonellosis and eggs. Br Med J 1988; **297**: 1557–8.
7. International Commission on Microbiological Specifications for Foods. Microbiol Ecology of Foods: vol 2: Food Commodities, pp 753–758. New York: Academic Press.
8. Petersen PJ. An outbreak of food infection caused by mayonnaise with *Salmonella typhimurium*. Medlemsbl Dan Dyrlaegeforen 1964; **47**: 284–7.
9. Meyer J, Oxhoj P. A salmonellosis epidemic. Medlemsbl Dan Dyrlaegeforen 1964; **47**: 810–19.
10. Rosdahl N. *Salmonella enteritidis* in gastroenteritis in a day-nursery. (Epidemiological observations in a primary food-borne infection). Ugeskr-Laeger 1980; **142**: (42) 2795–9.
11. Department of Health. Salmonella and raw eggs. Press release 1988; 26 August.
12. City of Westminster. Letter to all caterers and suppliers in the City of Westminster. 1988: September and December.

*Since this outbreak we understand that the caterers have been given Rabbinical approval to use pasteurized eggs.

13. Public Health Laboratory Service. Evidence to the Agriculture Committee Inquiry on Salmonella in Eggs. PHLS Microbiology Digest 1989; **6**: (1) 1–9.
14. Paul J, Batchelor B. *Salmonella enteritidis* phage type 4 and hens' eggs. Lancet 1988; ii: 1421.
15. Humphrey TJ, Cruikshank JG, Rowe B. *Salmonella enteritidis* phage type 4 and hens' eggs. Lancet 1989; i: 281.