

An investigation into an outbreak of *Salmonella enteritidis* phage-type 4 infection and the consumption of custard slices and trifles

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SUMMARY

Epidemiological investigation into an outbreak of food poisoning in 17 patients caused by *Salmonella enteritidis* phage-type 4 demonstrated a highly significant association with consumption of custard, retailed in custard slices and trifles from a bakery on one day. The bakery had changed their recipe for custard 2 weeks earlier to include fresh shell eggs and had not followed earlier national advice on cooking eggs for human consumption. The case-control study supports earlier work associating *Salmonella enteritidis* phage-type 4 infection with consumption of uncooked or lightly cooked shell eggs.

INTRODUCTION

A public health problem was recognized in 1988 when there was a large rise in human infections with *Salmonella enteritidis* associated in part with the contamination of hens' eggs. The nature of the problem was made public in 1988 [1, 2] and recommendations made by the Chief Medical Officer [3]; these were reiterated in 1990 [4]. He advised the public not to eat raw eggs or uncooked foods made with them and added that vulnerable people such as the elderly, the sick, babies and pregnant women should avoid lightly cooked eggs or food containing them. Nationally, evidence was presented to a parliamentary enquiry [5]. Locally the recommendations were drawn to the attention of traders by environmental health departments. Although informed, the bakery, in March 1991 changed its recipe for custard, retailed in trifles and custard slices, to one including fresh shell eggs. Three weeks later, environmental health officers were alerted to a cluster of *Salmonella enteritidis* isolations by reports from the local district hospital microbiology laboratory. Stool samples had been submitted from hospital and various general practices. Most were from a discrete locality, suggesting a point source.

METHODS

Preliminary investigation

Routine enquiries into food history and sources from six early reported cases identified custard (vanilla) slices from a local bakery, baked on site and eaten a week earlier, as a likely vehicle of infection. The bakery was visited and inspected by an environmental health officer the same day, and the manufacturing process,

health of staff, handling of ingredients and distribution of produce scrutinized. Custard from a common batch was used in the preparation of custard slices and individual trifles, both of which were associated with customers who became ill with *Salmonella enteritidis* (subsequently identified as PT4) infection. General practitioners were alerted to the problem by the Consultant in Communicable Disease Control (CCDC) who asked that all further possible cases be reported and stool samples submitted.

Case control study

A case control study was initiated to test the hypothesis that custard containing products (vanilla slices and trifles) produced at the bakery on 13–14 March 1991 and consumed between the dates in question were the vehicle of infection.

Primary case definition. An individual, first within a household and without contact with an earlier primary case, with a history of *any of* abdominal pain, vomiting, diarrhoea *and* a stool sample positive for *Salmonella enteritidis* phage type 4 (SE4) with onset of illness between 14 and 18 March 1991.

Control selection

(1) Cases were asked to nominate three people living in their locality, of the same sex, within approximately 10 years of their age.

(2) General practitioners of cases were asked to identify controls of the same sex as cases with the closest match possible for age.

In practice, only two cases offered any controls and a list of 51 controls was drawn up from GP age/sex registers. Failure to respond was largely due to the control being inaccessible either by having an ex-directory telephone number, or there being no reply when the number was rung on three occasions.

Thirteen out of 17 cases and 29 out of 51 controls responded to a simple, structured telephone questionnaire devised by the CCDC and senior environmental health officer (EHO) and applied by the senior EHO in person. Information on four cases who could not be contacted for the telephone enquiry was extracted from the original enquiry history sheets. The questionnaire was applied approximately 2 weeks after the putative exposure in the days approaching the Easter Bank Holiday. Questions were asked about illness, specific food eaten between 13 and 14 March 1991 and usual places of shopping. Responses were recorded as 'Yes/No/Uncertain'. Reference to the original enquiry history sheets allowed a validation check on some questions applied to the cases.

Results were entered into a computer database file and analysed using Epi-info Version 5 software. χ^2 and Fisher's exact tests were applied to results, as appropriate.

RESULTS

Pattern of illness

Twenty-seven laboratory isolations of salmonella subsequently identified as SE4, were reported in the District in the 6 weeks between 22 February and 2 April 1991. Within these there appeared a discrete episode reaching a peak of 21 isolations between 10 and 25 March, predominantly from one small town. From this latter group, 17 primary cases with dates of onset of illness between 14 and

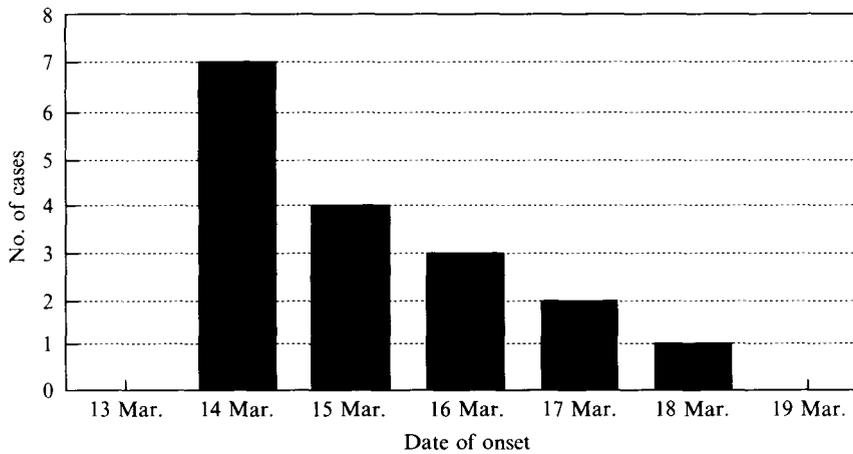


Fig. 1. Onset of illness.

18 March were identified for a case-control study, the selection being made by clustering in time. Nine of the cases were male and eight female and the age range was from 19–81 years.

Thirteen of the 17 had eaten custard slices or a custard containing trifle from the bakery (Table 1). One reported eating a custard slice from elsewhere. All had been purchased on 13 or 14 March, according to the customers' recall. Three could not be linked to the shop or a custard product. The first association between illness and the shop was through custard slices, but further enquiries of four subjects who were ill and certain that they had not eaten custard slices revealed that they had eaten trifles sold from the same shop on the same day, containing custard from the same batch as the custard slices.

Epidemic curve

The frequency of onset of illness was highest on 14 March, tailing off steeply over the next 4 days (Fig. 1). The incubation period was short – 1 or 2 days, where this could be confirmed, although one primary case had a possible incubation period of 5 days.

Clinical

Patients presented to their doctors with vomiting, diarrhoea and abdominal pain, which was severe in some cases. Active case finding did not reveal any further cases. Four patients were admitted to hospital, one of whom developed renal failure. Two patients without complications were hospitalized for over 1 week and were still positive for SE4 in the stool 2 months later.

Case control study

A positive association was demonstrated between cases and consumption of custard slices/trifles in a 2×2 table: χ^2 14.96 (Yates' correction) $P = 0.0001$ (Table 1). The tables were reported excluding 'uncertain' responses for the published analyses. However, recalculation of the tables assuming that they did eat, still returned a significant positive result for the custard products. A reasonable assumption would be that the majority did not consume the item under

Table 1. *Number of individuals consuming specific food*

Food	Person						χ^2*
	Case			Control			
	Yes	(Uncertain)	No	Yes	(Uncertain)	No	
Cream cake	1	(4)	12	8	(5)	16	1.78 $P = 0.12$
Bought sandwich	5	(4)	8	5	(0)	24	1.21 $P = 0.24$
Vanilla/custard slice/trifle	14	(0)	3	3	(8)	18	14.96 $P = 0.0001$
Omelette/lightly boiled egg	1	(8)	8	7	(15)	7	2.14 $P = 0.085$

* χ^2 calculated on 2×2 table excluding uncertain reports.

investigation. Similarly, exclusion of the initial six cases on which the hypothesis was based left a statistically significant association as reported. It is concluded that this association is robust as well as statistically significant.

Bakery and production method

The custard slices were produced at a bakery based at the centre of a small town, working from old premises. The bakery sold direct to the public and also supplied four other shops at different locations. The recipe for production of the custard, which was used in making custard slices and trifles, was changed early in March. Whereas previously it had been made from a commercial mix, this was changed to a traditional recipe including the use of fresh farm shell eggs. A variable amount of mix was made according to orders placed the previous day. A full measure of custard mixture included 24 eggs and this produced 100 custard slices. Where more than 100 were ordered, a supplemental mix of appropriate size was prepared. A small amount of fresh milk was added to a fresh egg/custard powder/sugar mix and the rest of the milk boiled then stirred into the mix. The product was allowed to cool at room temperature for 30 min, then piped onto a pastry layer which was then covered by another pastry strip and iced to produce custard slices. These were portioned onto bakery trays held at ambient temperature during storage or transport, but displayed at 10 °C in the shop. Forty slices were sold through the outlet at the production site and another 260 distributed to other outlets, on the day in question.

Eggs were purchased weekly, delivered from a local farm by a producer with several flocks of hens in this and other districts. The eggs used to prepare the batch of custard associated with illness had been delivered the previous week and stored at 3 °C in a refrigerator. The possible supplying farms were identified and responsible local authorities and Ministry of Agriculture Veterinary Investigation Department informed. All were inspected and their records were found to be in order, with no indication of any problem relating to bacteriological quality of the eggs.

Five members of the bakery staff admitted to having had gastrointestinal symptoms, and three were confirmed to have SE4 in their stools. One other

admitted to having had minor gastrointestinal illness 1 month earlier but had recovered fully and was asymptomatic at the time in question. The five had become ill at the onset of, or subsequent to, the outbreak. One was severely ill and was admitted to hospital. All had free access to the food in question. The three with positive stool results recalled eating vanilla slices and egg custard.

Bacteriology

Stool samples were submitted to the district general hospital laboratory by general practitioners, hospital doctors and environmental health officers. *Salmonella enteritidis* organisms were isolated from a total of 27 ill people between 22 February and 2 April. The isolates were submitted to the Department of Enteric Pathogens, Public Health Laboratory Service, Colindale, and confirmed as *Salmonella enteritidis* phage-type 4. Seven vanilla slices, taken 8 days after the suspected exposure date, were submitted to Leeds Public Health Laboratory, and SE4 was isolated from one. This slice was one of the last made from the 'fresh eggs' mix. Further samples submitted from the commercial powder mix later yielded no organisms. Eight shell eggs and sugar samples yielded no organisms. Custard powder was not tested. No environmental swabs were taken.

Management

The initial findings and hypothesis were discussed with the management of the bakery. Environmental health departments in other areas where the egg supplier had farms were informed of the situation, as was the veterinary investigation branch of the Ministry of Agriculture, Fisheries and Food. Routine procedures were invoked for checking the health of staff and laying off those who were ill. The attention of management was drawn to the advice of the Chief Medical Officer on the preparation of raw eggs for human consumption. Other similar businesses were identified from records held by the environmental health department and a general statement was issued drawing attention to guidance on use of raw eggs published in 1988.

DISCUSSION

This paper describes a discrete outbreak of *Salmonella enteritidis* phage-type 4 infection in a small town with a point source and clearly associated vehicle of infection.

The epidemiological evidence shows a strongly positive association suggesting a causal relationship between illness and consumption of home-made custard products from the bakery. Patient reports indicate 13 or 14 March as the day of consumption, but the epidemic curve of onset of illness makes 13 March the more likely date. Custard, retailed in custard slices and trifles from a single shop on 13 March, is therefore identified as the likely vehicle of infection, resulting in at least 17 cases of illness of sufficient severity that 4 were admitted to hospital. Although the organism was isolated from a further custard slice, produced some 8 days later, there was no evidence of a continuing outbreak beyond the period when most cases became evident.

Prompt intervention by environmental health officers on the basis of food histories, and the knowledge of the method of production of their suspect food

resulted in the initiation of appropriate action to prevent any further problem through the same vehicle.

The way in which the custard products became contaminated was not proven, and, because the investigation began only 8 days after the event, no direct bacteriological evidence was obtainable. Review of possibilities must be speculative, but in this situation raw eggs had been used and the advice from the Chief Medical Officer, relating to eggs, issued in 1988, was not followed. Earlier papers [5–12] have drawn attention to eggs as a source of infection with SE4 and the balance of probability would lead us to suspect eggs as the most likely source in this outbreak. In five outbreaks between July 1990 and September 1991 custard slices were suspected of being the vehicle of infection. In one the association was the *Salmonella typhimurium* and the others *Salmonella enteritidis*. The custard preparation did not involve fresh eggs in these incidents (CDSC, unpublished personal communication 1992 [13]). As no bacteriological evidence of contamination of eggs was found either on the bakery premises or in the farm records [14], further search on the farm was not possible [15]. No evidence was found of involvement of the other ingredients of the mix (custard powder, sugar and milk) or of environmental contamination from other products or from staff.

The reason why the outbreak had been tightly localized, when the bakery supplied a wider area, became clear only when the production process was reviewed. It was discovered that the custard mixture was prepared in variable batches equating to 100 slices or less. It is likely that the shop attached to the bakery was supplied last from a small batch of custard, enough only for its own needs.

The case control study was essential to amplify and support the conclusions of the descriptive epidemiology which alone may be open to challenge. Further, because there is a growing national problem with food poisoning due to SE4 infection, opportunities to contribute to defining the precise mechanisms of transmission are clearly not to be missed.

This incident provides further evidence that salmonella contamination in eggs is a continuing problem. Direct evidence however remains elusive. Equally important was the lack of recognition of any potential hazard introduced when the manufacturing process was changed thus emphasizing the need to maintain awareness of the public and trades.

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