Epidemiol. Infect. (1996), **116**, 161–167

Consecutive salmonella outbreaks traced to the same bakery

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(*Accepted 24 September 1995*)

SUMMARY

Two consecutive community outbreaks of *Salmonella enteritidis* phage type 4 (PT4) traced to the same bakery occurred in Cardiff, Wales during August–September 1992. In the first outbreak, illness was associated with eating custard slices (odds ratio 23·8, 95% confidence interval 6·5–94·4, $P < 0{\cdot}0001$), and in the second, with eating fresh cream cakes (odds ratio 15·8, 95% confidence interval 1·6–374, $P = 0{\cdot}004$). Environmental investigations implicated cross-contamination during preparation of the cold-custard mix as the cause of the first outbreak, and inadequate cleaning and disinfection of nozzles used for piping cream in the second outbreak. *S. enteritidis* PT4 was isolated from fresh cream sponge cake retained by a case and from two fresh cream cakes and four environmental swabs obtained at the bakery. This incident illustrates the hazard of widespread environmental contamination with salmonella and the need for thorough environmental cleansing of any premises implicated in an outbreak of food poisoning.

INTRODUCTION

Food poisoning outbreaks associated with bakery stores can have major public health significance [1, 2]. However, recurrent outbreaks associated with the same premises are uncommon. We report two consecutive salmonella outbreaks traced to the same premises, the second of which occurred despite explicit instructions on disinfection and food hygiene improvements following the first outbreak.

THE OUTBREAKS

Three people from the same household with suspected food poisoning were reported by the householder to the local Environmental Health Department on 10 August 1992 and faecal samples collected the next day were found to be positive for salmonellae. All three had become ill on the same day and all had consumed custard slices (a confectionery product comprising set custard between two pastry layers and topped with sugar icing) bought from a local bakery the day before. By 13 August, seven further cases of salmonella food poisoning associated with the same bakery had been confirmed. The bakery was inspected on 14 August and production of custard slices discontinued. The first Outbreak Control Team was convened on 17 August and advice issued to bakery staff on personal hygiene, appropriate cleaning procedures for equipment and kitchen surfaces, use of separate mixing bowls for products made from raw ingredients and the substitution of pasteurized egg for

recipes containing shell egg. By 28 August, no new cases with an onset after 10 August had been identified and the outbreak was considered to be under control.

However, during the first week in September, a further sharp rise in salmonella isolates was reported by local laboratories. Initial enquiries implicated cream cakes purchased from the same bakery between 25 and 29 August. An emergency prohibition order was served on the premises on 8 September requiring cessation of sale of all flour confectionery products. The Outbreak Control Team was reconvened on 9 September and further environmental investigations conducted including food sampling and extensive swabbing of food preparation areas. The bakery was once again requested to discontinue the use of shell egg and to improve routine cleaning procedures. No cases occurred with an onset date after 4 September.

METHODS

Epidemiological investigation

Case searching was undertaken by review of laboratory isolates of salmonella over the preceding 2 weeks and by alerting local general practitioners. In the first outbreak (Outbreak A), a case was defined as a person with microbiologically confirmed *Salmonella enteritidis* PT4 infection and a date of onset between 1 and 14 August 1992 who had been resident in the Cardiff area during the 3 days prior to illness. Secondary cases (those with onsets more than 24 h after the first positive in the household) were excluded. Two controls per case were chosen at random from the telephone directory using random numbers to select the page and then picking the first listed name matched for area of residence. A structured questionnaire was used to obtain personal details, clinical details and a food history for the 3 days prior to illness in the corresponding case. Details of place and date of purchase, and date of consumption of a range of specific foods eaten during the previous week including milk, eggs and egg products, poultry, meat, bakery and confectionery items were also sought. Nine controls who declined to take part in the study were replaced using the same random selection technique.

In the second outbreak (Outbreak B), a similar case definition was used with a date of onset of illness between 23 August and 5 September 1992. Because of the high proportion of child cases in the second outbreak, age-matched neighbourhood controls were used. Cases were asked to nominate two controls of similar age (within 10 years for adults, within 5 years for children and under 1 year for children under 1) from the immediate neighbourhood. The first eligible, contactable control was used. If cases were unable to nominate controls, these were selected by systematic neighbourhood searching following a predetermined protocol which involved visiting houses on the same side of the street until a household containing someone of similar age was found. Information was obtained by personal interview using a similar structured questionnaire to that used in the first study.

Data were analysed using Epi Info, Version 5 [3]. Food preference tables were constructed and odds ratios with Cornfield 95% confidence intervals (CI) calculated for matched and unmatched data. Probabilities were calculated using χ^2 with Yates' correction or Fisher's exact test as appropriate.

Environmental investigation

Detailed investigation of the bakery premises was carried out during both outbreaks. This included obtaining details of staff members and their job descriptions with respect to the manufacture of all flour confectionery products, details of production quantity, distribution and sale, and kitchen inspection to determine compliance with food hygiene regulations. After the second outbreak, a range of samples was obtained including both food ingredients and finished confectionery products, food debris samples and surface wipe swabs from food preparation and storage areas at the bakery.

Microbiological investigation

Faecal specimens were obtained from all staff employed at the bakery and examined for salmonellae. In Outbreak A, the only food samples available were a custard slice recovered from the dustbin of the index case and a sample of the same brand cold custard mix. In Outbreak B, 52 food samples and 48 environmental samples were obtained. All isolates were typed by the PHLS Division of Enteric Pathogens. Pyrolysis mass spectrometry (PyMS) typing [4] of 17 isolates (9 human, 4 food and 4 environmental) from both outbreaks was also performed.

RESULTS

Epidemiological investigation – Outbreak A

Between 1 and 14 August, 43 cases of *Salmonella enteritidis* PT4 from the Cardiff area were identified

https://doi.org/10.1017/S0950268800052390 Published online by Cambridge University Press

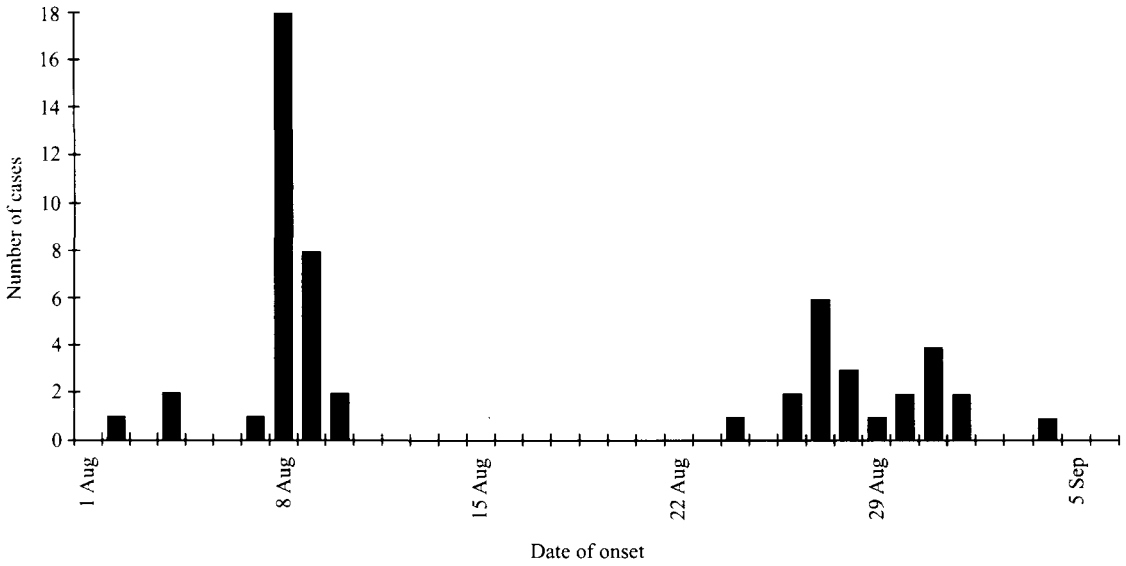

Fig. 1. Dates of onset of illness in two consecutive salmonella outbreaks.

Table 1. *Outbreak A – association between illness and foods eaten by cases and controls*

	Case ($n = 32$)		Control ($n = 59$)		
Food	Ate	Not ate	Ate	Not ate	Odds ratio (95% CI*)
Meat pies	1	31	13	46	0·11 (0·01–0·92)†
Meat pasties	2	30	5	54	0·72 (0·09–4·59)
Cold meat	15	17	37	22	0·52 (0·20–1·37)
Home cooked chicken	2	30	33	26	0·05 (0·01–0·25)‡
Eggs	10	22	35	24	0·31 (0·11–0·85)†
Mayonnaise	6	26	18	41	0·53 (0·16–1·65)
Ice cream	6	26	23	36	0·36 (0·11–1·11)
Cream cakes	1	31	6	53	0·28 (0·01–2·60)
Custard slices	22	10	5	54	23·8 (6·45–94·4)§
Custard tarts	0	32	4	55	0·00 (0·00–2·84)
Doughnuts	3	29	8	51	0·66 (0·13–3·06)

* 95% confidence interval.
† $P < 0{\cdot}05$.
‡ $P < 0{\cdot}001$.
§ $P < 0{\cdot}0001$.

by local laboratories. Thirty-two people met the case definition (after excluding 5 secondary cases, 4 who had travelled abroad and 2 who could not be contacted). Twenty-six of the cases became ill on the 8 or 9 August (Fig. 1). The median age of cases was 44 years (range 3–76 years) and 20 (63%) were women. All 32 cases had diarrhoea (6 with blood), 30 (94%) had abdominal pain, 29 (91%) had fever and 16 (50%) had vomiting. Median duration of illness was 7 days (range 2–13 days), and 6 cases required admission to hospital.

Fifty-nine controls were obtained and these were similar in respect of sex (70% women *vs.* 63%) but older (median age 58 *vs.* 44 years). Analysis of food histories demonstrated a highly significant association between eating custard slices and risk of illness (Table 1). Altogether, 22 of 32 (69%) cases had eaten custard slices compared with 5 of 59 (9%) controls (odds ratio 23·8, 95% CI 6·5–94·4, $P < 0{\cdot}0001$). Sixteen of 22 (73%) cases who had eaten custard slices compared with none of five controls had bought them from a retail outlet supplied by the same bakery. Cases were

https://doi.org/10.1017/S0950268800052390 Published online by Cambridge University Press

significantly less likely to report consumption of home cooked chicken, eggs or meat pies.

Epidemiological investigation – Outbreak B

Local laboratories identified 37 cases of *Salmonella enteritidis* PT4 during the period of the second outbreak. Nearly all lived in east Cardiff (where the bakery was located) and 21 of the cases were children. Twenty-two individuals met the case definition (after excluding 5 secondary cases, 7 who had travelled abroad and 3 who were notified too late to be included in the study). Nine of the 22 cases became ill on the 27 or 28 August with a second peak on the 31 August (Fig. 1). The median age of cases was 7 years (range 1–86 years) and 15 cases were under 15 years of age. All 22 cases had diarrhoea (8 with blood), 21 (96%) had abdominal pain, 19 (86%) had fever and 12 (55%) had vomiting. The median duration of illness was 6 days (range 3–19 days) and 5 child cases required admission to hospital.

Case-nominated controls were obtained for 16 of the 22 cases and the remainder were selected by systematic neighbourhood searching. Cases and controls were similar in respect of age (median age 7·0 *vs.* 6·5 years) but there was an excess of females among the cases (50% *vs.* 41%). Eleven of 22 cases had eaten a cream cake compared with 1 of 22 controls (odds ratio 21·0, 95% CI 2·2–494, $P = 0{\cdot}002$). Nine cases had eaten a fresh cream cake (one had a synthetic cream cake and one was unsure) compared with 1 control (odds ratio 15·8, 95% CI 1·6–374, $P = 0{\cdot}004$) (Table 2). Fifteen cases had eaten a product from the bakery under investigation compared with two controls (odds ratio 21·4, 95% CI 3·3–182, $P = 0{\cdot}0002$) and 10 cases had eaten a cream cake from the suspect bakery compared with none of the controls (odds ratio undefined, $P = 0{\cdot}001$). All but 3 had eaten the item on the day of purchase. No other single food item from the bakery was eaten by more than 3 cases.

Environmental investigation

The bakery comprised a shop, and at the rear, a bakery and cake preparation area separated by a flour store. Raw sausage meat and minced beef were delivered to the bakery daily; meat products were prepared in a separate area from the cakes. Raw poultry was not used on the premises, but 360 eggs were delivered weekly. Raw shell eggs were used for a range of cakes including scones, custard tarts and choux pastry. All cakes were prepared by a single member of staff. No staff members reported recent gastrointestinal illness.

Custard slices were made from layers of pastry baked the previous day, a cold custard mix and ready-prepared fondant icing. The cold custard mix comprised whole milk powder, modified starch, sugar, thickener, preservative, colouring and flavouring which was reconstituted with tap water and mixed in a stainless steel bowl with a mechanical whisk. Immediately prior to reconstitution of the cold custard mix the same bowl was used to mix milk and eggs for the baked custard tarts, and then washed in hot water and dishwashing detergent. The same stainless steel table was used for the production of both custard tarts and custard slices. Around 360 custard slices were made daily, about a third were offered for sale at the main bakery and the remainder delivered by van to 10 other retail outlets, usually as part of a tray of assorted cakes. None of the outlets kept custard slices under refrigeration prior to sale. Although the bakery egg supplier was readily identifiable, attempts to trace eggs to their original source were unsuccessful.

Following the second outbreak, cake preparation procedures were again reviewed. Several other potentially hazardous practices were identified including use of the same mixing bowl for raw shell egg mix and synthetic cream, storage of synthetic cream in an uncovered, unrefrigerated container, and inadequate cleaning of cream piping bags and nozzles. Despite advice to the contrary, raw shell eggs were still in use at the bakery and the same area was used for preparing egg-containing products and other confectionery items.

Microbiological investigation

All faecal samples submitted by bakery staff were negative. None of the eggs from the batch in use at the time of the outbreak were available for microbiological testing, but a sample of the cold custard mix was negative for salmonellae. A custard slice recovered from the domestic waste bin of one of the cases was positive for *Salmonella enteritidis* PT4. Following the second outbreak, *S. enteritidis* PT4 was found in fresh cream sponge cake retained by a case, from two fresh cream cake samples obtained at the bakery, and in

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Table 2. *Outbreak B – association between illness and foods eaten by cases and controls*

Food	Case ($n = 22$) Ate	Not ate	Control ($n = 22$)* Ate	Not ate	Odds ratio (95% CI†)
Meat pies	3	19	3	19	1·00 (0·14–7·37)
Meat pasties	2	20	4	18	0·45 (0·05–3·43)
Cold meat	8	14	10	11	0·63 (0·15–2·52)
Home cooked chicken	6	16	8	13	0·61 (0·14–2·63)
Eggs	9	12	7	15	1·61 (0·39–6·74)
Mayonnaise	2	19	3	19	0·67 (0·07–5·79)
Ice cream	6	16	8	13	0·61 (0·14–2·63)
Any cream cakes	11	11	1	21	21·0 (2·21–494)‡
Fresh cream cakes	9	12	1	21	15·8 (1·63–374)‡
Custard slices	2	20	1	21	2·10 (0·13–63·8)
Custard tarts	1	21	2	20	0·48 (0·02–7·59)
Doughnuts	5	17	3	19	1·86 (0·31–11·9)

* Some subjects were unable to recall consumption history for some food items.
† 95% confidence interval.
‡ $P < 0·01$.

environmental swabs taken from the surfaces of two cake preparation tables, a shelf in the dry store and the surface of a weighing scale pan. PyMS typing showed 14 isolates (8 human, 3 food and 3 environmental) to be definitely related.

DISCUSSION

These 2 community outbreaks of *S. enteritidis* PT4 of same PyMS type occurring 2 weeks apart were both traced to bakery confectionery produced by a single bakery. The vehicle of infection in the first outbreak was custard slices from a single day's production at the bakery sold at a number of independent retail outlets. Unlike a previously described outbreak involving custard slices, the custard was made from a reconstituted custard powder mix and did not contain eggs [5]. A sample of residual custard powder mix was negative for salmonellae. However, detailed enquiry suggested the possibility of cross-contamination since the same mixing bowl was used first for preparing an egg-containing mixture and immediately afterwards for reconstituting the custard powder. In the second outbreak, fresh cream cakes purchased from the same bakery were implicated by the case-control study and *S. enteritidis* PT4 was isolated from fresh cream cakes still on sale at the bakery. Unlike the previous outbreak, cakes had been purchased over a number of days suggesting a continuing source of contamination. Environmental investigation suggested that piping nozzles used daily for making fresh cream cakes were inadequately cleaned potentially allowing cross-contamination.

Second outbreaks after thorough investigation and appropriate control are unusual and may arise for a number of reasons. Contaminated food may be retained and served over a period of several days [6], infected food handlers may perpetuate transmission through contamination of a range of food items [7, 8], or dissemination of organisms and contamination of the environment may occur [9–11]. Relatively small doses of salmonella have been shown to cause illness in outbreak settings and salmonella can survive for long periods on or in foods not commonly implicated in outbreaks, particularly those with high fat content such as cheese and chocolate [12–14]. Transmission may therefore occur in settings where neither gross contamination nor prolonged growth of salmonella in food items has taken place. Dissemination of micro-organisms may follow cross-contamination from raw meat or poultry [8–10]. More recently, contamination of hands and work surfaces with *S. enteritidis* has been demonstrated experimentally during the preparation of egg dishes [15]. Some organisms survived washing with soap and hot water, widespread distribution of contaminated droplets occurred and *S. enteritidis* was recovered from work surfaces 24 h later.

Possible explanations for the incident we describe

https://doi.org/10.1017/S0950268800052390 Published online by Cambridge University Press

include a continuing or intermittent common source such as an infected food handler or an environmental reservoir. However, all food handlers were screened and were negative after the first outbreak and none reported symptoms until after the second outbreak. Furthermore, different types of ingredients were used in the cakes implicated as the vehicles of infection. The first outbreak was probably due to cross-contamination following introduction of salmonella into the bakery (possibly from a contaminated shell egg) whilst the second outbreak may have been caused either by a second contaminated shell egg (the bakery used the same egg supplier throughout) or by widespread contamination of the bakery environment following the first outbreak. The hiatus between outbreaks A and B supports the former hypothesis but no direct evidence of contaminated eggs was found nor any evidence that cream might have been cross-contaminated from another egg-containing product. By contrast, there was microbiological evidence of extensive contamination of the bakery environment at the time of the second outbreak.

Interestingly, the controls in Outbreak A were significantly more likely to have eaten home cooked chicken than cases. Poultry is a well recognized source of *S. enteritidis* PT4 in the UK and, since persons with recent illness were excluded as controls, this observation may indicate a greater likelihood of acquired immunity to salmonella as a result of frequent previous exposure. Similar observations have been reported in relation to campylobacter enteritis [16].

Routine hygiene inspections of food premises by enforcing authorities are designed to identify and remedy potential problems. Failure to comply with food hygiene standards have been shown to predict outbreaks of food borne illness [17]. In theory, it should be straightforward to prevent outbreaks by giving appropriate advice but in practice this can prove difficult. Even repeated penalizing of a restaurant after unsatisfactory routine hygiene inspections failed to prevent one major salmonella outbreak [18]. This incident illustrates the problems of securing compliance with advice on food hygiene improvement even in the context of an outbreak. Despite thorough, supervised environmental cleansing after the first outbreak, the routine daily cleaning regime of equipment by the bakery seems to have remained sub-standard. We would therefore emphasize the importance of ensuring that advice on food hygiene given during salmonella outbreaks is followed through and that strenuous measures are taken to ensure disinfection of utensils and work surfaces in order to prevent contamination of the environment.

ACKNOWLEDGEMENTS

The authors wish to thank others involved in the investigation, particularly the staff of Cardiff Environmental Services and Cardiff Public Health Laboratory. We are grateful to the PHLS Communicable Disease Surveillance Centre (Welsh Unit) for epidemiological advice, the PHLS Laboratory of Enteric Pathogens for phage typing and to Dr John Magee for carrying out the PyMS testing.

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