

A LARGE POINT-SOURCE OUTBREAK OF *SALMONELLA* TYPHIMURIUM PHAGE TYPE 9 LINKED TO A BAKERY IN SYDNEY, MARCH 2007

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Abstract

This report describes the investigation and public health response to a large point-source outbreak of salmonellosis in Sydney, Australia. The case-series investigation involved telephone interviews with 283 cases or their guardians and active surveillance through hospitals, general practitioners, laboratories and the public health network. In this outbreak 319 cases of gastroenteritis were identified, of which 221 cases (69%) presented to a hospital emergency department and 136 (43%) required hospital admission. This outbreak was unique in its scale and severity and the surge capacity of hospital emergency departments was stretched. It highlights that foodborne illness outbreaks can cause substantial preventable morbidity and resultant health service burden, requiring close attention to regulatory and non-regulatory interventions. *Commun Dis Intell* 2010;34(1):41–48.

Keywords: outbreak, foodborne illness, *Salmonella*, bakery

Introduction

Foodborne illness accounts for an estimated 32% of gastroenteritis illness in Australia, causing around 5.4 million episodes of illness, 18,000 hospitalisations and approximately 120 deaths annually.¹ *Salmonella* infection (mainly *Salmonella* Typhimurium) is predominantly a foodborne illness in Australia with annual seasonal peaks in the summer months.^{2,3} In early 2007, *Salmonella* notifications in New South Wales increased to levels well above previous years⁴ in part due to the outbreak reported in this paper.

On the evening of Monday 26 March 2007 a hospital emergency department (ED) in Sydney notified the Sydney South West Area Health Service (SSWAHS) Public Health Unit (PHU) of 5 people (three from the same family) with severe acute gastroenteritis who had presented to this ED reporting that they ate food from the same bakery, five to 24 hours prior to becoming ill. In the ensuing days this evolved to be one of the largest *Salmonella* outbreaks reported in New South Wales. The pathogen responsible was subsequently determined to be *Salmonella*

Typhimurium phage type 9. This paper describes the public health investigation and response to the point-source outbreak.

Methods

Epidemiological investigation

Active case findings were conducted by requesting that other public health units in New South Wales, EDs and general practitioners (GP) notify the PHU of any possible cases. Laboratories and EDs close to the premises were contacted for updated possible case listings on a daily basis for 1 week.

Cases were also identified through routine laboratory notification of *Salmonella* species and *Salmonella* Typhimurium between 19 March and 10 April 2007. Case details were verified against an electronic clinical information system for probable cases who presented to facilities within the SSWAHS (n = 125). Where a person was unable to be contacted directly, details were verified by discussion with the treating clinician or the notifier.

Details were collected on all food eaten in the 3 days preceding onset of illness for the first 20 cases notified to the PHU to confirm that food from the bakery was the only common exposure, hypothesising that this was the likely source of gastroenteritis illness. Other cases were interviewed with a standardised questionnaire to characterise exposure and obtain demographic, illness and exposure details. A case was defined as 'any person who had a consistent illness with symptoms of either diarrhoea and/or vomiting AND who ate food prepared at the bakery between 19 and 27 March 2007, prior to the onset of their illness'. Cases were confirmed by interview with the case or by discussions with treating clinicians.

All 5 symptomatic food handlers were interviewed. All symptomatic food handlers working at the bakery had stool cultures for *Salmonella* and arrangements were made for asymptomatic food handlers to be screened.

Six weeks after the commencement of the outbreak the SSWAHS PHU conducted a sub-investigation. Forty-five cases were randomly selected for follow-

up interview to obtain information on illness duration, illness severity and contact with health care facilities. The subset was randomly select using a random number generator matched with case identification numbers.

Data were entered into Epi Info 3.3.2 for Windows (CDC, Atlanta, GA, USA), and analysed using SAS System® version 8.02 and Microsoft® Excel 2000.

Environmental investigation

The NSW Food Authority was notified of the initial cluster of gastroenteritis cases by the PHU on the evening of Monday 26 March and inspected the bakery the following day. Food handling and cleaning practices were reviewed as part of the environmental investigation. Food items were sampled for microbial testing and environmental samples were taken from surfaces and equipment where food was prepared. A trace-back of all foods served at the premises was initiated, which included an inspection of an egg farm. The farm inspection involved a review of egg handling procedures and the collection of egg and environmental samples for microbial testing. Environmental samples included chicken faeces specimens, meat meal, stock feed and drag swabs collected from 4 laying sheds. Samples were tested by the Division of Analytical Laboratories.

Laboratory investigation

Salmonella isolates from stool and blood specimens, were cultured at laboratories throughout Sydney, and collated by the PHU. Serotyping of human *Salmonella* isolates and isolates from food and environmental sources collected at the food premises was performed by the Institute of Clinical Pathology and Medical Research and collated by the PHU. Multiple locus variable number of tandem repeats analysis (MLVA) was performed on these isolates.^{5,6} These isolates were then tested by multiplex polymerase chain reaction-based reverse line blot (mPCR/RLB) phage-type (PT) prediction assay.

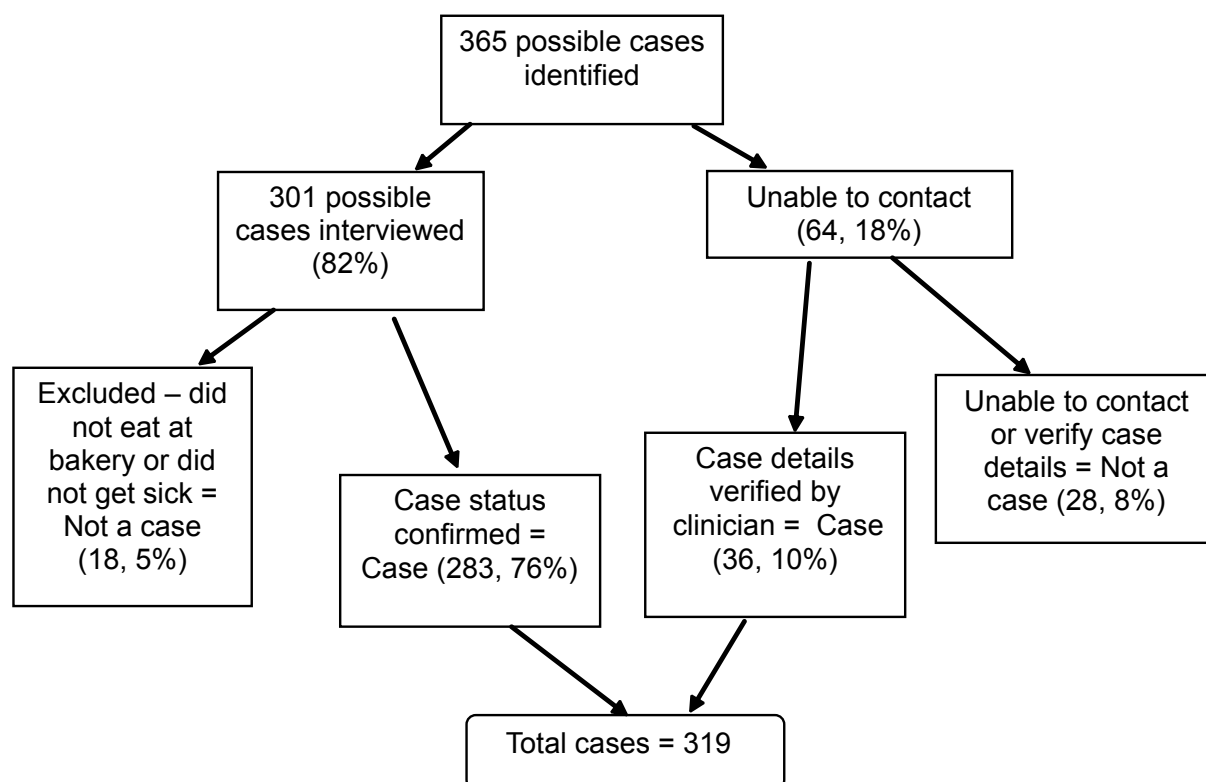
Results

Epidemiological investigation

The SSWAHS PHU was notified of 365 possible cases, from which 319 cases were identified. Of these, 283 were interviewed. The remaining 36 cases were confirmed by contacting the treating clinician (Figure 1). Five cases were food handlers who worked at the bakery and reported eating food from the bakery prior to becoming unwell. Onset dates for the food handler cases were between 23 and 27 March.

Demographic details are contained in Table 1. Cases were aged between one and 74 years

Figure 1: Case verification process

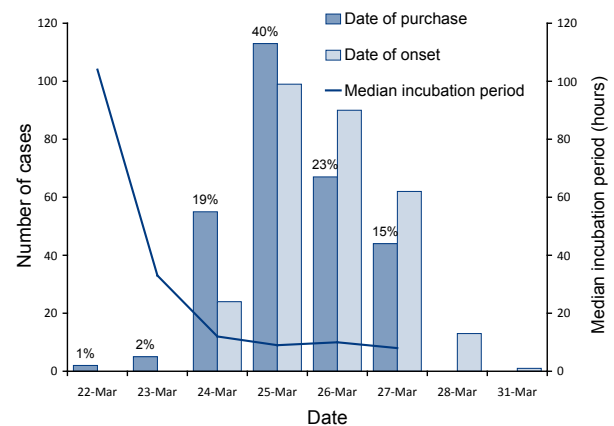


(median = 31 years) and most cases were male. Figure 2 contains the epidemic curve and the date of purchase of food from the bakery. The peak of the outbreak occurred on 25 and 26 March with 67% (189/283) of cases reporting disease onset on these 2 days. Incubation periods ranged from one to 118 hours (median 10 hours). The median reported incubation period decreased as the outbreak progressed (Figure 2); ranging from 104 hours for cases who purchased food on 22 March ($n = 2$) to 8 hours for those who purchased food on 27 March ($n = 44$).

Food was purchased by cases between Thursday 22 March and Tuesday 27 March (Figure 3). All but 7 cases purchased food over a 4-day period, with 40% (113/283) being purchased on a single day. Forty-four cases reported purchasing food on 27 March, after the outbreak was notified. Of these, 28 were admitted to hospital. All cases interviewed reported that they ate a chicken, pork or salad roll from the bakery prior to becoming unwell (Table 2). While most cases reported that they ate a whole roll prior to becoming unwell, 14 cases reported that they ate only a very small amount of the roll, as little as a single bite.

Attack rates could not be calculated, however, the owners of the food premises estimate that 320 pork rolls would be sold over a 5 day period (40 on week-days and 100 weekend days). On 3 days at the peak of the outbreak (Sunday, Monday and Tuesday) the number of cases who purchased food exceeded the

Figure 2: Number of cases and incubation period (hours), *Salmonella* Typhimurium outbreak, Sydney, March 2007, by date of onset and date of purchase



estimated number of rolls sold. The attack rate on these days therefore is likely to be close to 100%, although it may be much less on other days.

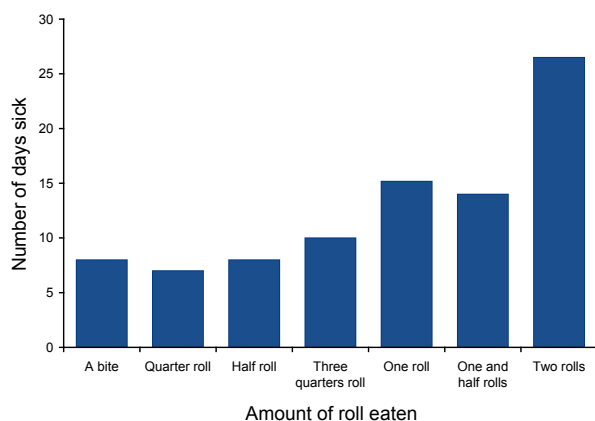
There were 8 food handlers at the bakery. Of these, five met the case definition and six had positive stool cultures for *Salmonella* Typhimurium phage type 9, with one initially being reported as asymptomatic. Later in the investigation this food handler admitted to having some stomach pain after consuming a small amount of a pork roll on 27 March.

Table 1: Demographic and clinical characteristics for cases, *Salmonella* Typhimurium outbreak, Sydney, March 2007 ($n = 283$) and a subset of 45 cases interviewed a second time to determine illness severity and duration

Sex	Full outbreak		Illness severity subset	
	n	%	n	%
Male	171	60.4	21	46.7
Female	112	39.6	24	53.3
Age group				
0–9	10	3.5	2	4.4
10–19	62	21.9	11	24.4
20–29	57	20.1	10	22.2
30–39	55	19.4	9	20.0
40–49	48	17	6	13.3
50–59	28	9.9	4	8.8
60+	9	3.2	2	4.4
Unknown	14	4.9	1	2.2
Symptoms				
Diarrhoea	268	94.7		
Fever	235	83.0		
Vomiting	186	65.7		
Headache	185	65.4		

Table 2: Foods eaten by cases, *Salmonella* Typhimurium outbreak, Sydney, March 2007 (n = 283)

	Yes	No	Unknown	Percentage
Bread roll	280	1	2	98.9
Salad vegetables	263	10	10	92.9
Mayonnaise	149	82	52	52.7
Pate	138	86	59	48.8
Pork	149	108	26	52.7
Chicken	103	152	28	36.4
Ham	94	95	94	33.2
Salad only, no meat	14	269	0	04.9

Figure 3: Dose response curve: Amount of roll eaten, *Salmonella* Typhimurium outbreak subset of 45 cases, Sydney, March 2007, by number of days sick

During the outbreak, most cases (94%, 301/319) presented to a health care provider; 80 of these presented only to their GP and 69% (221/319 cases) presented to a hospital ED. A large number of the cases (62%, 136/221) who presented to EDs required hospital admission. Median duration of hospital admission was 24 hours. One case reported being admitted for 8 days. Of those cases who presented to a hospital within the SSWAHS boundary (n = 125), 65% of cases required hospital admission, with a median duration of 31 hours. Cases presented to 26 different hospitals across New South Wales. Seventy-six cases (24%) related to this outbreak presented to a single hospital ED over a 4-day period; 42 (13%) cases presented to a second hospital. These 2 hospitals are located within 5 kilometres of the bakery. Most presentations occurred on a single day.

Sub-investigation of illness severity

Of the 45 cases in the sub-analysis group (demographic characteristics are shown in Table 1), illness duration (defined as number of days before the case reported their health returned to normal) ranged from three to 45 days (median 14 days); at least

5 people reported still being unwell at the time of second interview. Eighteen per cent of this subset purchased food on 24 March, 40% on 25 March, and 20% on either 26 or 27 March. Thirty-nine of these cases (87%) reported taking time off work or school due to the illness; 20 cases reported taking less than a week off work or school, 14 between one and 2 weeks, one between two and 3 weeks and three greater than 3 weeks. Fifty-six per cent of this subset of cases indicated on questioning that they required intravenous fluid replacement at the time of the acute illness. Figure 3 displays a dose-response curve for this subset of cases, showing that duration of illness increased with the estimated quantity of the food eaten.

Laboratory findings

Salmonella Typhimurium was cultured on stool from blood from 173 cases (54%). Thirty-nine human isolates from cases were typed using MLVA and had MLVA type 01-03-20-04-06. These isolates exhibited a phage reaction pattern on mPCR/RLB that was consistent with *Salmonella* Typhimurium phage type 9, subsequently confirmed by phage typing. No other types of *Salmonella* were isolated from cases.

Environmental investigation

The bakery is a busy premises located near a train station in the inner west of Sydney. The bakery had previously been inspected by the NSW Food Authority in September 2005 during a food handling survey. The premises consisted of a shop fronted by a serving counter and a rear preparation area. The front counter was fitted with a glass pastry display unit and an adjoining takeaway food bar unit used to display ingredients for the preparation of pork and chicken rolls. The rolls contained any combination of ingredients including sliced hams, sliced pork, marinated cooked diced chicken, pate, raw egg mayonnaise, shredded carrot, coriander and cucumber.

The inspection and interviews with the owners of the premises revealed that there was a lack of effective sanitation of food handling equipment and surfaces. It was also noted that there was a refrigeration malfunction in the early hours of the morning of 25 March (after the outbreak had commenced). Inadequate refrigeration was also recorded for the raw egg mayonnaise in the display unit.

Salmonella Typhimurium phage type 9 was detected in 15 isolates from food and environmental samples taken at the source premises. *Salmonella* Typhimurium was isolated in the raw egg mayonnaise, ham, pork, chicken, pate and shell eggs and from swabs of the preparation bench, tongs, meat slicer, floor drain and display tray. All isolates from food and environmental samples were MLVA type 01-03-20-04-06, which is identical to that isolated from cases. A quantitative analysis of the raw egg mayonnaise sample yielded a count in excess of 1.1×10^7 colony forming units/mL.

The eggs used in the raw egg mayonnaise were traced to a farm in outer Sydney. The farm was inspected on 4 April 2007. The drag swab from a laying shed on the egg farm and from a meat meal sample were positive for *Salmonella* although subsequent serotyping and phage typing revealed that the egg farm isolates did not match the human and food isolates linked to the outbreak.

During the inspection of the premises on the morning of 27 March the NSW Food Authority removed the raw egg mayonnaise from sale. By 5 pm 27 March, a prohibition order was issued to the premises by the NSW Food Authority to prevent sale of chicken and pork rolls and associated ingredients. Upon receipt of analytical results a subsequent prohibition order was issued on 30 March preventing the business from operating.

Discussion

This describes one of the largest point source outbreaks of *Salmonella* in Australia for many years. Similar outbreaks linked to Vietnamese pork rolls in Victoria in 1997 resulted in 774 and 154 cases.⁷ Other large outbreaks in recent years have related to commercially available products, including chicken meat⁸ and fruit juice.⁹ In the outbreak described in this report, routine surveillance through statutory reporting and active case finding identified 319 cases, about half of which were laboratory confirmed. This outbreak is notable for its scale, the severity of illness experienced by the cases and the degree of contamination at the point source.

A large proportion of cases required hospital admission, with many requiring prolonged stays. Hospital admission for salmonellosis generally only occurs in

more severe cases, with most cases (estimated to be over 90%) being treated in the community.¹ In this outbreak, two-thirds of all identified cases presented to an emergency department at some point during their illness and half were admitted to hospital. In addition, the average duration of illness in this outbreak was long. Salmonellosis usually results in diarrhoea lasting 3–7 days,³ whereas an average duration of diarrhoea of 14 days was observed in this outbreak, and many experienced illnesses of longer duration of up to 45 days. Over half of the cases in this sub-investigation reported requiring intravenous fluid replacement due to dehydration, further indicating that illness was severe.

It is estimated that the attack rate was close to 100%, which is consistent with or higher than similar outbreaks reported elsewhere.^{10–13} The incubation period decreased as the outbreak progressed, indicating significant contamination at the point source, and likely bacterial growth in foods and spread to surfaces as the outbreak progressed. Inadequate temperature controls when storing foods, as was found in the environmental investigation, would have contributed to bacterial proliferation. The environmental investigation revealed widespread contamination throughout the premises; *Salmonella* was detected in most foods used in the preparation of the chicken and pork rolls, on the food slicer, preparation bench, serving tongs, display tray and floor drain. As a result, a specific source of contamination was not established. It is clear, however, that there were deficiencies in food handling and sanitation contributing to the proliferation of the organism and its spread throughout the premises after the initial contamination occurred. Similar deficiencies in handling and cross contamination were noted in 2 other outbreaks linked to similar premises in Victoria.⁷

The 2 most likely sources of the initial contamination are the eggs used for the raw egg mayonnaise or, less likely, an asymptomatic food handler. *Salmonella* was identified in the stool of a food handler with only mild symptoms of stomach pain after the outbreak had subsided, but it was not possible to confirm whether carriage commenced during or prior to the outbreak. Positive stool specimens were found in 2 asymptomatic food handlers working at a bakery associated with an outbreak of *Salmonella* Typhimurium phage type 9 in Victoria in 1997.⁷ The significance of detection of *Salmonella* in this previous outbreak was also not established. Under the *NSW Food Act 2003* (with reference to the *Australia New Zealand Food Standards Code* covering health and hygiene requirements for food handlers)¹⁴ food handlers with symptoms of foodborne illness, or carriage, are prohibited from handling food if there is a possibility they may contaminate it. NSW Health recommends that food handlers who have diarrhoea are excluded from work for 48 hours after

symptoms resolve. Neither the *NSW Food Act 2003* or the *Food Standards Code* allow for this and consideration should be given to strengthen, and clarify, the restriction of food handlers who are ill.

Salmonella Typhimurium phage type 9 was identified on the shells of one open tray of eggs kept on the premises. However, no *Salmonella* was found on eggs contained in 2 closed cartons also on the premises. Traceback to the farm identified other *Salmonella* serovars but not *Salmonella* Typhimurium phage type 9, however it is possible that *Salmonella* serovars may move in and out of poultry flocks with the introduction of contaminated feed, or other inputs and excretion of *Salmonella* may be intermittent.¹¹ Raw eggs are frequently implicated in large outbreaks of *Salmonella*¹¹ and in this outbreak it is believed that heavily contaminated mayonnaise, and subsequent cross contamination was the most the likely cause. Egg related outbreaks have increased in Australia in recent years. OzFoodNet data show that there have been 63 outbreaks in the last 3 years where egg or egg based dishes were suspected to be the source; 14% of all foodborne illness outbreaks in 2005 were considered to be related to eggs, compared with 23% in 2008.^{15–20} While eggs are the most likely vector for the majority of these outbreaks, poor hygiene and food handling at retail level is also a major contributing factor and influences the size and severity of the incident.

There are several approaches to reduce the occurrence of such large outbreaks resulting from service of high risk foods, including raw egg based products. Starting with a raw product that has the lowest level of contamination possible is key. The reduction of pathogens on egg farms is a priority and many countries have developed schemes and/or regulations to reduce human pathogens such as *Salmonella* and *Campylobacter* in poultry.^{21,22} In Australia, Food Standards Australia New Zealand (FSANZ) is developing a Primary Production and Processing Standard for Eggs and Egg Products.²³ This will impose requirements on producers and users of eggs at the primary production and retail level. The draft standard addresses specific food safety risks associated with cracked and dirty eggs and prohibits sale of unpasteurised egg pulp for retail or catering purposes. In New South Wales, the NSW Food Authority will be responsible for implementation and enforcement of the national standard. Additional cooperation between government regulators and industry is vital to ensure that food safety measures are of the highest standard to protect public health. Stronger, proactive engagement by government with industry, including the egg industry, will assist with better sharing of information and earlier identification of hazards in the food production chain.

The NSW Food Authority is working with all New South Wales local councils, who are responsible for routine inspection of retail businesses such as bakeries and cafés, to educate businesses on the risks of using products containing raw eggs. In 2005 the bakery at the source of this outbreak was presented with information about the risks of raw egg based foods and also advised to use a commercial, pasteurised mayonnaise product. This advice was ignored and a large fine was subsequently imposed by the courts as a result of prosecution action undertaken by the NSW Food Authority. This is a powerful deterrent for businesses to avoid using raw egg products where possible. Standard fact sheets and warning letters have been developed for distribution by local council officers to businesses where these are found to be using raw egg products.

The widespread contamination in the bakery indicates that food handling skills were not adequate. A national food handler survey undertaken by FSANZ in 2007 indicated that bakeries were less proficient in food handling activities compared with other businesses surveyed.²⁴ Protecting public health through food safety is primarily the responsibility of jurisdictional food regulators. The NSW Food Authority is responsible for regulating the food industry through the *NSW Food Act 2003*. This Act, through the *Food Standards Code*, requires food handlers to have adequate skills and knowledge in food safety and food hygiene if employed in food service. The owner of the business is responsible for ensuring staff have adequate skills and knowledge appropriate for their activities within the business. However, no formal training is currently required, even for the owner. In New South Wales this is being addressed through implementation of a Food Safety Supervisor Initiative. This will require every retail food business in New South Wales to have a dedicated food safety supervisor with responsibility for staff training. The scheme will be implemented in the middle of 2010.

Outbreaks, even in small premises, can result in high morbidity, high cost to the community and have a significant impact on health care provision. The scale and impact of this outbreak augurs for continued investment in risk assessment and food safety measures at all stages throughout the food chain and regulation of primary producers and food premises.

The most notable feature of this outbreak is its scale, the health and economic consequences for those affected and the resultant burden on the health system of a preventable foodborne illness. This outbreak is likely to have resulted in considerable costs to the healthcare system and the community. Given the number of people presenting to EDs and requiring admission to hospital, the cost to the hospitals involved would have been significant.

This outbreak was initially reported to local health authorities by an astute ED clinician. Early notification by clinicians requires the development of good relationships with their local public health authority. Continued co-operation between NSW Health and the NSW Food Authority will provide for early identification of outbreaks and timely public health action to protect public health. These authorities must seek to continually improve outbreak response procedures to reduce the impact on public health through, among other avenues, regular evaluation of outbreak response. Based on the estimated attack rate and the degree of environmental contamination, it is likely that the closure of the bakery prevented many more cases occurring. The co-operation and timely communication between clinicians at the coal face, public health officials and the regulators provided an opportunity for urgent and responsible public health action.

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