International epidemiological and microbiological study of outbreak of *Salmonella agona* infection from a ready to eat savoury snack—I: England and Wales and the United States

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Abstract

Objectives—To identify the source of an international outbreak of food poisoning due to *Salmonella agona* phage type 15 and to measure how long the underlying cause persisted.

Design—Case-control study of 16 primary household cases and 32 controls of similar age and dietary habit. Packets of the implicated foodstuff manufactured on a range of days were examined for salmonella. All isolates of the epidemic phage type were further characterised by pulsed field gel electrophoresis.

Results—27 cases were identified, of which 26 were in children. The case-control study showed a strong association between infection with *S agona* phage type 15 and consumption of a peanut flavoured ready to eat kosher savoury snack imported from Israel. *S agona* phage type 15 was isolated from samples of this snack. The combined food sampling results from the United Kingdom, Canada, the United States, and Israel showed that contaminated snacks were manufactured on at least seven separate dates during a four month period between October 1994 and February 1995. Voluntary recalls of the product successfully interrupted transmission.

Conclusions—Rapid international exchanges of information led to the identification of the source of a major outbreak of *S agona* in Israel and of associated cases in North America. The outbreak showed the value of the Salm-Net surveillance system and its links outside Europe, both for increasing case ascertainment and for improving the information on the duration of the fault at the manufacturing plant.

Introduction

Between 5 December 1994 and 30 January 1995, 27 isolates of *Salmonella agona* were identified in England and Wales (see fig 1) compared with 12 in the same period a year earlier. Many of the cases were in children, there was geographical clustering, and most of the children had Jewish surnames. We investigated the cause of this food poisoning by means of a case-control study and microbiological testing of the implicated foodstuff.

Subjects and methods

Parents of eight primary household cases were interviewed using a wide ranging semi-structured questionnaire asking about recent food consumption. Four parents each reported that their child had eaten a kosher, peanut flavoured ready to eat savoury snack made of maize and imported from Israel.

Case finding was extended outside England and Wales using Salm-Net, a network for the surveillance of salmonellosis in Europe.¹ Information was shared with

public health colleagues in other countries, including Israel, the United States, and Canada.

We performed a case-control study of primary household cases in England and Wales between 1 December 1994 and 9 February 1995. A case was defined as *S agona* of the outbreak strain isolated from a faecal specimen in a child under the age of 10 with an associated diarrhoeal illness. Cases were considered to be secondary if another household member had a diarrhoeal illness in the 24 to 72 hours before the onset of their own illness. Cases were excluded if they had been abroad within the week before the onset of diarrhoea. Parents of cases were asked to nominate three families living in their neighbourhood who were likely to eat kosher food and had a child aged within two years of the case. Controls were excluded if they had been abroad recently or had had a diarrhoeal illness since 1 December 1994. Cases interviewed in the preliminary enquiry were included in the study but separate analyses were undertaken both with and without these cases. A questionnaire requesting information on foods consumed by cases in the three days before illness and by controls in the three days before interview was administered by telephone to parents on 9 and 10 February. The food history included reference to a range of savoury snack products both from the manufacturer of the peanut flavoured snack and other manufacturers in the United Kingdom and Israel.

All isolates of *S agona* from human cases since 1 December 1993 have been phage typed. All isolates of the epidemic phage type were further characterised by pulsed field gel electrophoresis.² Packets of the peanut snacks, purchased from retailers, were opened aseptically and the contents (25 g) were examined for *Salmonella* spp by a standard method.³ The importer and distributor of the implicated snack was approached to obtain details of batch numbers and manufacture dates.

Results

DESCRIPTIVE EPIDEMIOLOGY

The epidemic strain of *S agona* was identified as phage type 15. Between 1 December 1994 and the time when interviews in the case-control study were conducted 41 cases of *S agona* infection were identified. Twenty four were *S agona* phage type 15, 23 of them were in children aged 7 years or younger, six of them being under 1 year (fig 1). Fifteen of the 24 cases lived in London, eight lived in four different cities, and one lived in Israel. Three further cases infected with *S agona* phage type 15, all in children under 5 years old who had eaten the savoury snack, were reported by the end of March 1995. In the 13 months from November 1993 to November 1994, before the increase in incidence of *S agona* infection, 18 cases of infection with *S agona* phage type 15 were identified, of which six were in children. Pulsed field gel electrophoresis showed that these

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18 strains were different from the outbreak strain. Interviews of a sample of these cases did not show any association with eating a kosher diet or the peanut snacks.

CASE-CONTROL STUDY

Of the 23 cases of infection with *S agona* phage type 15 in children, two children were abroad and not contactable and five others were excluded from the analysis because the organism had been isolated before 1 December (one), they were possible secondary cases (three), or there was a refusal to cooperate (one). Two potential controls were excluded—one had a diarrhoeal illness and the other a recent history of travel abroad. The median age of cases was 22 months (range 10 months to 5 years 11 months) and that of controls was 30 months (range 16 months to 6 years 4 months). Cases were ill for a median of six days (range 2 to 40), and two cases were admitted to hospital. Fifteen of the cases and all 32 controls were reported to always or sometimes eat kosher food.

When cases from the preliminary inquiry were excluded from the analysis a strong association was found between consumption of the savoury snack and infection with *S agona* phage type 15 ($P=0.0002$) (table 1). The association became stronger if all cases were included in the analysis. None of the other foods showed an independent association with illness.

MICROBIOLOGY

In total 83% (44/53) of the packets of the savoury snack that had been manufactured on 6 November 1994 with a best before date of the end of April 1995 and had been obtained from retailers contained *S agona* phage type 15. In eight packets subjected to quantitative

studies the estimated salmonella count ranged from 2 to 45 organisms per packet (25 g). Three out of 28 packets manufactured on 6 October 1994 with a best before date of the end of March 1995 were also contaminated with *S agona* phage type 15. One hundred and eighty seven packets from the batch with a best before date of the end of May 1995, which was the batch most commonly available in shops at the time of sampling, were tested and no evidence of salmonella contamination was found. About 20 000 packets of the snack of the batch manufactured on 6 November 1994 were distributed in the United Kingdom.

INTERNATIONAL RESULTS

A large outbreak of *S agona* was reported to be under way in Israel and is described in the accompanying paper.⁵ Although no increase was noted in the overall number of *S agona* infections in the United States, follow up interviews of 26 cases were conducted in four states. Ten cases reported eating the implicated snack before becoming ill, and all their strains isolated were phage type 15. Packets tested in the United States that were manufactured in Israel on 30 October 1994 were contaminated (D Morse, personal communication), as were those tested in Canada that were manufactured on 4 October, 18 November, and 19 December 1994 (J Guzewich and T Gleeson, personal communication), and those tested in Israel that were manufactured on 6 February 1995.⁵ *S agona* phage type 15 isolated in Israel, North America, and England from cases and snacks were indistinguishable when tested together.² None of the 13 European countries contacted through Salm-Net reported any increase in numbers of *S agona* isolations.

CONTROL MEASURES

A government food hazard warning identifying the contaminated batch of the savoury snack was issued on 10 February. The company subsequently agreed not to distribute other batches or to import further batches until investigations were completed. The product was also recalled in the United States and Canada. Several additional preventive measures were introduced to the manufacturing process at the production plant in Israel, as described in the accompanying paper.⁵

Discussion

Timely national laboratory based surveillance allowed prompt government action. Recognition of the outbreak and the source of infection was aided by the comparatively low numbers of *S agona* infections reported annually in England and Wales, the specific group infected, and the geographical clustering of cases. Within a week of the initial case interviews, subsequent epidemiological investigation and isolation of the organism from the product led to effective government control measures.

Young children are both a vulnerable population for infection with salmonella and major consumers of snack products. The peanut flavoured snack was eaten by children as young as 10 months old. Identification of such products as vehicles of infection in children may be

Fig 1—Distribution of cases of *Salmonella agona* infection, England and Wales, 1994-5

Table 1—Association between illness due to *Salmonella agona* phage type 15 and consumption of the kosher savoury snack

	Cases			Controls			Odds ratio (95% confidence interval)	P value (Fisher's exact test)
	Ate snack	Did not eat snack	Not sure	Ate snack	Did not eat snack	Not sure		
All cases	13	1	2	4	27	1	87.8 (7.5 to 2400)	<0.00001
Subset of cases*	6	0	2	4	27	1	(14.6† to ∞)	0.0002

*Cases from preliminary inquiry excluded (see text).

†Lower limit by profile likelihood approach.⁴

Key messages

- Large, widespread international outbreaks of foodborne disease may result when faults occur in modern food production processes
- International surveillance networks can strengthen infection control
- When a foodstuff is contaminated it is important to examine as many batches as possible to show the duration of the production fault

difficult as snacks may be eaten outside the home and parents may not be aware of consumption.

Contaminated snacks were manufactured on at least seven separate dates over four months, indicating that the production fault was prolonged. The degree of contamination was expected and found to be low.⁶

The *S agona* outbreak demonstrates the importance of communication and collaboration between health officials locally, nationally, and internationally. Sharing of information led to voluntary recalling of the product in North America and in England and Wales, as well as to the identification of the source of a major outbreak in Israel.⁵ With the modern worldwide distribution of food products, the Salm-Net surveillance network has a crucial role in rapid case finding and information exchange within Europe and further afield.¹⁻⁷

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International epidemiological and microbiological study of outbreak of *Salmonella agona* infection from a ready to eat savoury snack—II: Israel

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Abstract

Objectives—To explain an increase in the incidence of salmonellosis caused by *Salmonella agona* in Israel between October 1994 and January 1995 in the light of an outbreak of *S agona* phage type 15 infection in England and Wales caused by consumption of a ready to eat savoury snack produced in Israel.

Design—Epidemiology of *S agona* in 1994–5 was analysed and two consecutive, case-control studies of 32 and 26 case-control pairs were performed. Phage typing and molecular methods were used to characterise strains of *S agona* isolated from cases and samples of the snack in Israel and England and Wales.

Results—The increase in the incidence of *S agona* between October 1994 and January 1995 was countrywide. Cases of infection with group B salmonella increased from 60% to 80% in children under 5 years old. In both case-control studies, cases consumed more of the snack than did controls (4.25 v 2.94 packets per week in the first study ($P=0.086$) and 4.04 v 2.37 packets per week in the second study ($P=0.034$)). When the two studies were combined there was a significant dose-response relation for the number of packets consumed weekly. Compared with consumption of

less than two packets, the odds ratio was 1.43 for between two and six packets and 3.37 for seven or more packets (χ^2 for trend=5.27, $P=0.02$) *S agona* phage type 15 was isolated from a packet of the snack sold in Israel, and the strain was identical with those isolated from packets and cases in Israel and England and Wales.

Conclusions—This outbreak of *S agona* was caused by the contamination of a snack produced in Israel. Even under modern operating conditions, large, widespread international outbreaks of foodborne disease can occur. The success of this investigation resulted from excellent international collaboration between public health authorities.

Introduction

During October 1994 to January 1995 there was a sharp increase in the incidence of *Salmonella agona*, a group B salmonella, in Israel.¹ The increase was countrywide, and epidemiological investigations failed to identify a source. On the 14 February 1995 a report was received of a small outbreak of *S agona* infection in England and Wales that was associated with contamination of a ready to eat, kosher, savoury snack manufactured in Israel.^{2,3} We began a study to determine whether consumption of the same snack was responsible for the outbreak in Israel.