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An outbreak of *Salmonella blockley* infections following smoked eel consumption in Germany

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SUMMARY

In June 1998, an increased number of persons with *Salmonella blockley* infection were reported from one German state. Because *S. blockley* is extremely uncommon in Germany, a case-control study was performed in order to find the source. A total of 13 patients met the case definition. Nine of 12 cases and 2 of 21 controls with food consumption histories reported eating smoked eel (OR 28·5; 95% CI 3·9–235·3). The consumed eel came from four different local smokeries, but could be traced back to fish farms in Italy. This outbreak indicates that eel may be a vehicle for salmonella infection and that the smoking process may not eliminate bacterial contamination from raw fish.

INTRODUCTION

In 1997, 105340 infections with *Salmonella* spp. were reported in Germany [1]. One of the rarest serovars in Germany is *S. blockley*, which accounts for less than 0·5% of human isolates [2]. Similarly, *S. blockley* has infrequently been identified as a cause of outbreaks in Europe [3] as well as in the United States [4]. Consumption of fish is responsible for 5–8% of foodborne disease outbreaks in Europe and the United States [3–5]. However, outbreaks from salmonella due to fish consumption are very uncommon [4].

In June 1998, 14 persons with *S. blockley* infection were reported in Germany. Ten of these persons lived in one federal state (Mecklenburg-Vorpommern), seven of whom were in one county of this state. In the previous year, 28 persons with *S. blockley* infection were reported in all of Germany. We report the results of an outbreak investigation which indicated that this increase was related to imported smoked eel consumption. To our knowledge, consumption of eel has not been previously reported as a cause of a foodborne outbreak of salmonellosis.

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METHODS

A case-control study was performed in order to identify the probable vehicle of infection. Cases were defined as persons who lived or stayed temporarily in Mecklenburg-Vorpommern between 26 May and 8 June 1998 and who had *S. blockley* isolated from a stool specimen. Each case was asked to nominate two neighbourhood controls. If nobody was nominated, two persons listed with the same street name as the corresponding case were chosen from the telephone book and contacted in the order of their appearance in the book. A total of 21 persons were willing to participate as controls. Between 14 August and 2 September, telephone interviews using standardized questionnaires gathered information about demographics, symptoms and the consumption of selected food items 3 days before disease onset for the cases

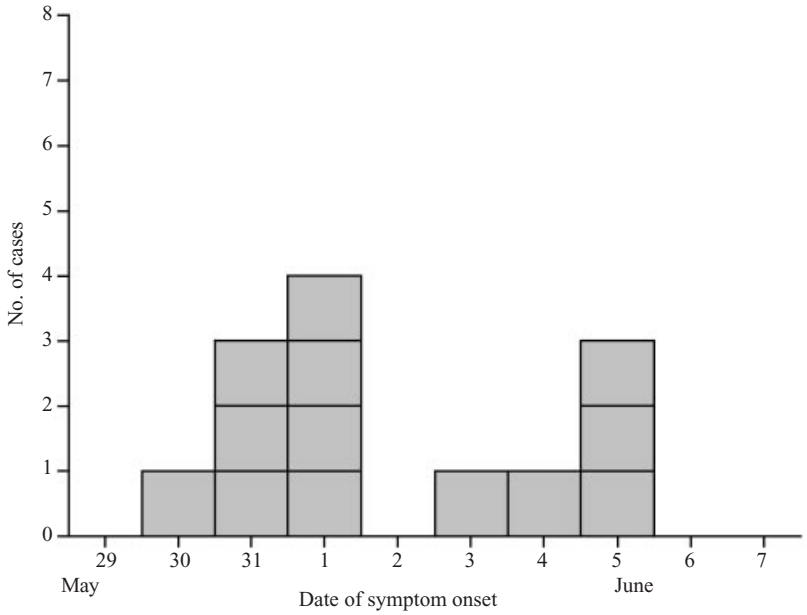

Fig. 1. Number of persons with *S. blockley* infection by date of symptom onset, May–June 1998, Germany.

and for the week before the interview for the controls. Odds ratios and their 95% confidence limits for differences in food consumption between cases and controls were calculated using Epi-Info version 6.03 [6].

Because the initial interviews of some cases suggested smoked fish from a local smokery as a possible cause of the outbreak, a site visit to that smokery took place on 12 August. Samples from smoked eel and herring as well as swabs from the environment (cold storage room, fish container, working desks, hand-basin) were taken. In addition, the smoked fish consumed by each case was traced back to its origin using records from local fish handlers and distributors.

S. blockley isolates from 9 case-persons as well as 10 comparison *S. blockley* strains originating elsewhere were sent to the German National Reference Centre for Salmonellae and other Enteric Pathogens (NRC) for determination of antibiotic resistance and for molecular typing. Antibiotic resistance was determined using a microtitre dilution test [7]. Plasmid DNA of *S. blockley* strains was extracted by the method of Kado and Liu [8]. Genomic DNA embedded in agarose was prepared as earlier described [9] and digested with the restriction endonucleases *Xba*I and *Spe*I. Pulsed-field gel electrophoresis (PFGE) was carried out using the CHEF-DRII or CHEF-DRIII electrophoresis system (Bio-Rad) in 1·2% agarose gels at a constant voltage of 200 U at 14 °C in 0·5 × TBE buffer. The run time and pulse time was for *Xba*I 5–60 s over 30 h and 20–50 s over 15 h and for *Spe*I 7–15 s over 22 h and 20–50 s over 22 h. Chromosomal DNA of *S. typhimurium* LT2 digested with *Xba*I was used as molecular size marker [10].

RESULTS

A total of 13 persons living in 2 federal states and in 5 different counties met the case definition. Their mean age was 37 years (range 7–62 years) and 10 (77%) were male. All cases had symptom onset from 30 May to 5 June 1998 (Fig. 1). The mean duration of illness was 9 days (range 4–21 days). All reported diarrhoea (3 or more loose stools in 24 h), 12 reported abdominal cramps, 8 reported fever above 38·5 °C and 5 reported vomiting. There were 3 family clusters, 1 with 3 and 2 with 2 cases.

Cases were substantially more likely than controls to have eaten smoked eel (OR 28·5; 95% CI 3·9–235·3; Table 1). Although cases were also more likely than controls to have eaten smoked halibut (Table 1), 2 of the 4 cases who had eaten smoked halibut had also eaten smoked eel. Cases were no more likely than controls to have eaten any other food item.

The smoked eel consumed by the 9 cases who reported eating it, was bought directly from 2 local smokeries (5 cases), at a local market (2 cases), at a local fish shop (1 case) or consumed in a restaurant (1 case). Four local smokeries were identified as primary source of all the incriminated eel. All 4 obtained eel from 2 wholesalers. The wholesalers bought live eel

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Table 1. *Food items consumed by persons with* S. blockley *infection and controls, Germany 1998*

Food items	Cases ($n = 13$)*		Controls ($n = 21$)*		Odds ratio	95% CI
	n	(%)	*n*	(%)		
Smoked eel	9	(69)	2	(10)	28·5	3·9–235·3
Smoked halibut	4	(31)	0	(0)	Undef.	1·9–undef.
Mackerel	0	(0)	1	(5)	0·0	0·0–30·7
Trout	2	(15)	1	(5)	4·0	0·3–123·3
Beef	1	(8)	9	(43)	0·1	0·0–1·1
Poultry	7	(54)	15	(71)	0·5	0·0–2·3
Pork	6	(46)	20	(95)	0·1	0·0–0·6
Sausage	8	(62)	19	(90)	0·8	0·1–27·8
Egg dishes	8	(62)	15	(71)	0·6	0·1–3·0

* Denominator totals may vary slightly due to missing responses.

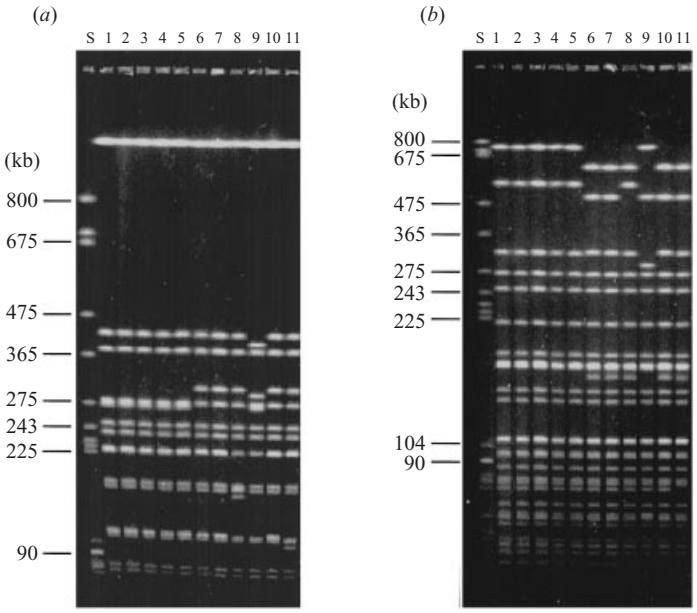

Fig. 2. Pulsed-field gel electrophoresis (PFGE) of *S. blockley* strains from five case-patients (lanes 1–5), and from six *S. blockley* comparison strains (lanes 6–11); lane S, *S. typhimurium* LT2. (A) *Xba*I-digested; (B) *Spe*I-digested. PFGE patterns from additional case-patients not depicted were identical to the five shown here.

from different fish farms in one Italian province (Veneto). Two of these farms delivered live eel to the two wholesalers simultaneously in May and June 1998. The eel was transported in water tanks to Germany. During its 3-day journey, the water is normally changed once, usually in Austria.

The food specimens and environmental swabs taken from the local fish smokery were negative for *Salmonella* spp. and other pathogens. No food specimens from the time of the outbreak were available for microbiological analysis. The local smokeries involved in this outbreak were small plants which performed a hot smoking procedure using traditional ovens without automatic temperature regulation or operating programmes that could guarantee that sufficient temperature levels to inactivate salmonella inside the smoked fish were achieved.

The *S. blockley* isolates from stool specimens of nine case-persons showed an unusual antibiogramme (resistance to kanamycin/neomycin, streptomycin, sulphonamides and tetracycline) and the presence of two small cryptic plasmids sized 4·2 and 3·0 MDa. The isolates also had an identical restriction fragment pattern by PFGE that was different from those of the comparison strains (Fig. 2).

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DISCUSSION

The results of the case-control study indicated that smoked eel was the most likely cause of the outbreak. The identical antibiotic resistance patterns and PFGE patterns among *S. blockley* strains from the cases also suggested a single common source. Although the location and means of the eel contamination remain unknown, the fact that four local smokeries and two wholesalers had been involved suggests that the eel contamination must have occured during farming in Veneto, Italy, or during transport to Germany.

It is noteworthy that surveillance data provided by the Instituto Superiore di Sanita (http://193.205.224.34) indicate that in 1997, *S. blockley* isolates from Italy were 1·3 times (95% CI 1·04–1·6) more likely to originate from Veneto than from all other Italian provinces.

Although fish are not regarded as a typical reservoir for salmonella, *Salmonella* spp. isolations from the aquatic biosphere, including living fish, mussels, live eel and water from their ponds, have been reported [11–14]. Sporadic reports about salmonellosis after consumption of smoked fish indicate that bacterial pathogens in infected fish may survive the hot smoking procedure [15–17]. One experimental study of herring during smoking indicated that an oven temperature of 105 °C for at least 1 h was necessary to ensure that a sufficient temperature was reached for a sufficient time to inactivate salmonella inside the fish tissue [18]. Although the smokeries involved in this outbreak used a hot smoking procedure, the lack of automatic equipment made it more likely that sufficient conditions to inactivate salmonella were not reached.

We conclude that smoked eel can be a cause of salmonella outbreaks. When fish such as eel are contaminated with salmonella, the hot smoking procedure under field conditions may be insufficient to eliminate the potential threat of an outbreak.

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