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A community waterborne outbreak of gastro-enteritis attributed to *Shigella sonnei*

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SUMMARY

An outbreak of gastro-enteritis occurred in a community of 2213 persons located near the city of Ioannina, in North-western Greece. Two hundreds and eighty-eight inhabitants of the village of Eleoussa, suffered from gastro-enteritis between 11 and 22 October. The peak of the epidemic occurred during the first 3 days (11–13 October). The highest risk of developing gastro-enteritis was observed in the age group 0–14 years (41·4%) and decreased significantly with age ($P < 0{\cdot}01$). Patients over 65 years were more frequently hospitalized than those in other age groups ($P < 0{\cdot}05$). *Shigella sonnei* was isolated from both, water samples and faeces of patients. Control measures were implemented on the second day of the outbreak. Environmental conditions suggest that contamination of the water system occurred by groundwater.

INTRODUCTION

Waterborne disease outbreaks occur every year in Greece, and other Mediterranean countries. They may appear in communities and even in small towns, as these systems are not regularly chlorinated in many cases [1–3].

These outbreaks are rarely studied. However, it seems that *Shigella sonnei* is a relatively common cause of illness related to contaminated drinking water in Greece. *S. sonnei* had been isolated from the drinking water or from stool cultures of some cases during at least two important outbreaks that occurred in small cities of Greece. It seems also that this micro-organism could be responsible for a number of outbreaks occurring in relatively large communities, using a common water system [3–5].

For a relatively large number of waterborne outbreaks the cause remains uncertain, as they occur in communities located in a distance from water control centres, and they are inadequately investigated. In these cases the responsible organisms cannot be isolated and the identification of a waterborne source is usually based on epidemiological evidence. So, it is important to study the epidemiologic characteristics of outbreaks related to well known microbiological factors and environmental conditions, as this knowledge could be helpful for the investigation of other outbreaks due to uncertain causes.

The purpose of this study was to determine the cause and the conditions of an outbreak of gastro-enteritis, that occurred in a community located near the city of Ioannina, in North-western Greece, and to examine the characteristics of the epidemic curve, as well as the impact of this outbreak for the community.

MATERIALS AND METHODS

Environmental study

The community of Eleoussa is located at a distance of 3 km from the city of Ioannina, the capital of a district with a population of about 150000 inhabitants. The

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community studied has a population of 2213 inhabitants, according to a census carried out with the help of local authorities.

In 1996, a community water system served almost the whole population of the town, using groundwater from a single borehole as one source. The system was not regularly chlorinated. The sewage network was in a satisfactory condition.

One 300-ml water sample was collected about four times per year, as routine, and submitted to the Laboratory of Hygiene of the University of Ioannina, which tested the samples for total and faecal coliforms using the membrane filtration method [6]. The first day after the outbreak had been recognized (11 October 1996) the Laboratory of Hygiene collected three samples from the water distribution system, one sample from the tank, and one sample from the pumping station. On 13 October a 1-l sample was collected from the pumping station. This sample was filtered and tested for the presence of salmonella and shigella, using an enrichment technique with sterile 0·1% peptone water. Serological identification was performed using the slide agglutination technique with shigella antisera (polyvalent and type-specific sera) [6, 7].

The identification of the responsible micro-organism was based on a sample from the pumping station because local authorities proceeded to an immediate chlorination of the water-distribution system and the tank. Water samples were also collected and analysed during the next 15 days.

Cases

The sources used to identify cases were in- and out-patients suffering from gastro-enteritis illness, and referred to the General Hospital of Ioannina as well as to the University Hospital of Ioannina.

All patients suffering from gastro-enteritis, resident in the community of Eleoussa and referred as in- or out-patients between 11 and 22 October 1996 have been recorded. No community cases of gastro-enteritis had been referred in the community 5 days before and 5 days after this time period.

Laboratory studies

A total number of 366 specimens (rectal swabs) were examined for the isolation of shigella. All specimens were obtained from 112 patients, 74 children (< 14 years) and 38 adults, presented as in- or out-patients at the University Hospital of Ioannina, during the period. Three rectal swabs taken from each patient were transported to the laboratory in transport medium (Cary-Blair, BBL Diagnostic) for culture. All specimens were processed within 1 h of their collection. Each was inoculated onto MacConkey and Salmonella–Shigella (SS) agar, and GN enrichment broth. GN broths were subcultured to SS agar within the first 4–8 h of incubation. The isolated strains of *S. sonnei* were identified by standard bacteriological and biochemical procedures. They were further identified using the API system (20E). *S. sonnei* was confirmed by serologic testing (Murex-Diagnostic Welcome polyvalent and monovalent antiserum) [8, 9].

Antibiotic susceptibility

Antibiotic susceptibility tests were performed using the disk diffusion (Bauer–Kirby) method according to the NCCLS. Antibiotic disks were obtained from Sanofi-Pasteur Diagnostics. Ampicillin, cefotaxine, cefrazidine, cefepime, tetracycline, ciproflaxin, ofloxacin, trimethoprim/sulfamethoxazole (co-trimoxazole), chloramphenicol and imipenem were tested [10].

RESULTS

Two hundreds and eighty-eight (288) inhabitants of the village of Eleoussa, suffering from gastro-enteritis were recorded between 11 and 22 October. The peak of the epidemic occurred during the first 3 days (11–13 October) (Fig. 1). The highest risk of developing gastro-enteritis was observed in the age group 0–14 years. The risk decreased significantly with age (χ^2 test: $P < 0{\cdot}01$) and was lowest in the age group 65 years and over (Table 1).

Figure 2 shows the likelihood of hospitalization of a gastroenteritis case for different age groups. Patients over 65 years were more frequently hospitalized than those in other age groups ($P < 0{\cdot}05$).

Of 366 examined specimens, *S. sonnei* strains were isolated from 100, 70 from children and 30 from adults. All these epidemic strains had an identical API 20E profile (1104112) and identical resistance to antibiotics (resistant to ampicillin, co-trimoxazole and tetracycline). *S. sonnei* isolated from water sample had the same resistance profile.

Water samples collected from the tank and the distribution system were free of coliforms. The presence of total and faecal coliforms in water samples

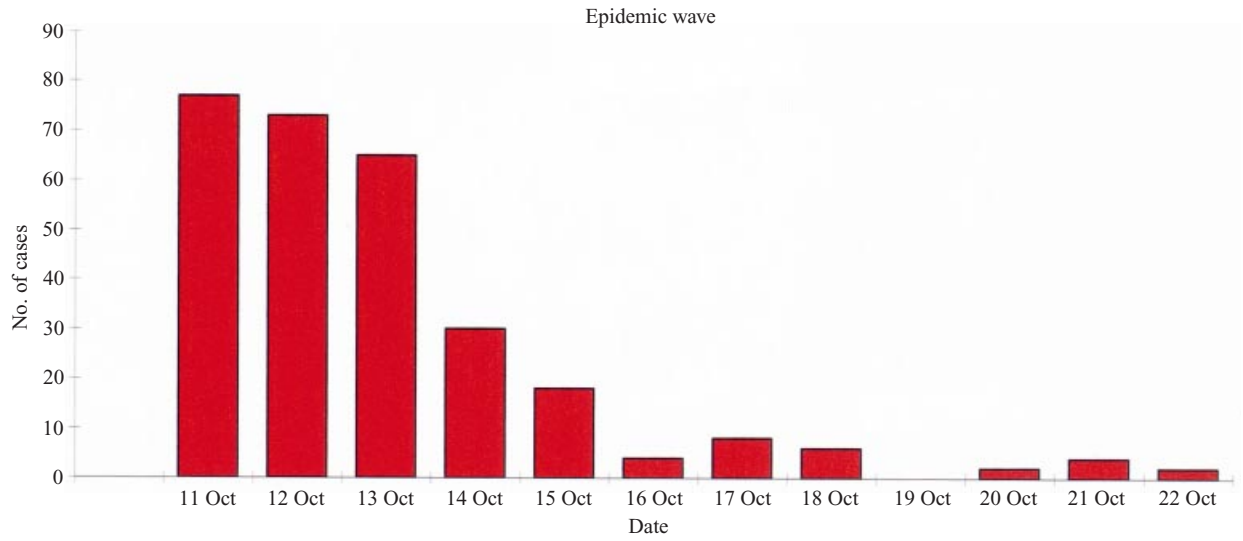

Fig. 1. Epidemic curve.

Table 1. *Frequency of gastroenteritis by age and sex*

	No. of cases			Attack rate (95% CI)		
Age (years)	Male	Female	Total	Male	Female	Total
0–14	75	81	156	38·1 (27·4–5·17)	45·0 (34·1–57·2)	41·4 (32·8–48·2)
15–44	47	47	94	9·8 (2·7–21·8)	10·0 (2·9–22·0)	9·9 (4·8–17·6)
45–64	10	13	23	3·8 (0·1–17·4)	4·8 (0·1–17·9)	4·3 (0·1–16·8)
65+	7	6	13	4·6 (0·1–17·1)	3·0 (0·1–16·6)	3·7 (0·1–17·3)
Unknown	1	1	2			
All ages	140	148	288	12·7 (8·1–19·4)	13·2 (8·6–19·9)	13·0 (7·6–14·8)

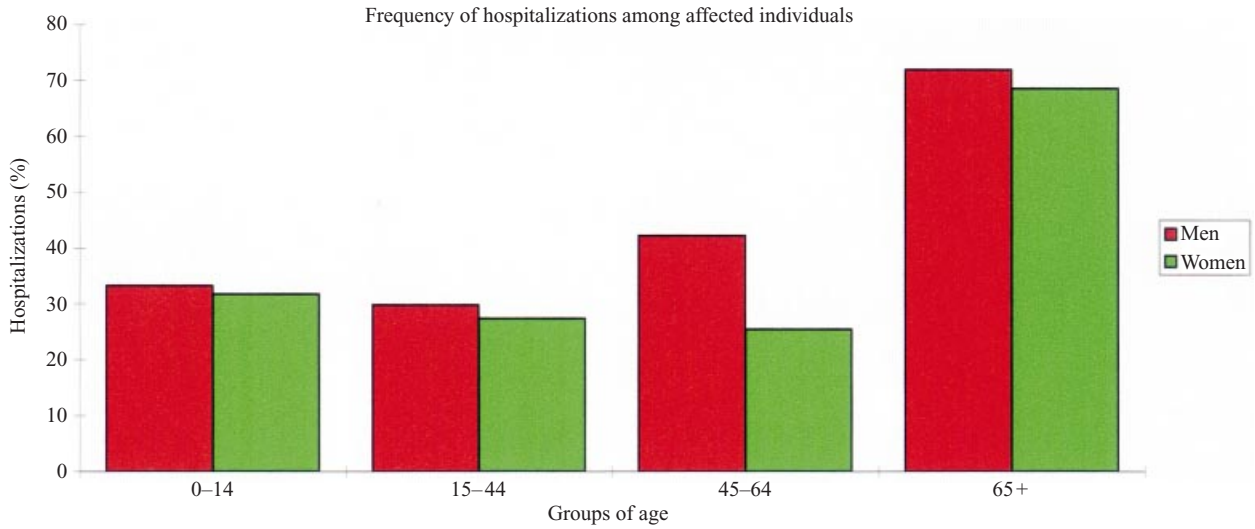

Fig. 2. Frequency of hospitalization among affected individuals.

collected from the pumping station, during the outbreak is shown in Table 2. *S. sonnei* had been isolated from a sample taken from the pumping station (above).

The well was inspected and found to be situated near some isolated residences, outside the village. These houses were at the same level as the well, not connected to the sewage network, and used septic

Table 2. *Water samples collected from the pumping station during the outbreak* (*colonies per 100 ml of sample*)

Date	Total coliforms	Faecal coliforms	Faecal streptococci
12 Oct. 1996	91	57	20
15 Oct. 1996	20	9	1
18 Oct. 1996	155	125	5
21 Oct. 1996	28	15	2
24 Oct. 1996	22	9	0
27 Oct. 1996	3	0	0

tanks or rarely waterproof pits. There was a milk factory about 200 m from the well. The well was covered and the pumping station was situated nearby. There were no obvious signs of damage to the structure of the well. The underlying rock from which the water was abstracted, was calcareous and the depth of the borehole was about 60 m.

DISCUSSION

S. sonnei is a well-known cause of gastrointestinal illness, and a common cause of bacillary dysentery in many countries. There are many potential sources of an outbreak due to *S. sonnei*, related to several transmission ways. Foodborne and waterborne outbreaks are not uncommon, but also person-to-person transmission and even swimming-related outbreaks have been reported [10–14].

Waterborne outbreaks are not generally related to faecal contamination of the groundwater, although such outbreaks can occur. On the other hand the responsible micro-organisms are rarely isolated from water sources. The identification of a waterborne outbreak usually is based on epidemiological evidence [10].

During the outbreak studied, *S. sonnei* has been isolated and identified in both, water source and stool cultures of many cases. There is also strong suggestion that contamination of the water system occurred through the groundwater. The antibiotic resistance profiles of all isolates was identical, indicating that the organisms belonged to a single strain. The epidemic curve suggests a specific microbiological factor widespread as a result of specific environmental conditions.

The impact of the outbreak in terms of morbidity and health services utilization was important. There were at least 288 cases of gastro-enteritis in the community of Eleoussa between 11 and 22 October, an attack rate of 13·4%. Ninety-one patients (33·1% were hospitalized. No deaths occurred.

It is possible that a number of patients with mild symptoms did not contact any hospital. It is known that shigella infection can be present with mild or no symptoms [15, 16]. We should also consider that a small number of patients would have contacted private physicians. They would not be recorded. This number is expected to represent a very small percentage of total cases. Eleoussa is placed at a small distance from the city of Ioannina, and there were no private physicians or other health services in Eleoussa, at the time of the outbreak.

Inadequate specifity of diagnosis might also be a source of bias, although the study is based on cases diagnosed in a hospital. It is also difficult to identify primary and secondary cases in the frame of this study.

A number of residents of the village probably had some degree of natural immunity to shigellosis, as the environmental conditions related to this outbreak had existed for years, but we have no information about the frequency and distribution of this immunity among people resident in the community [17].

These methodological problems pose some limitations to the interpretation of our data, but there is strong indication that the epidemic curve showed a characteristic peak during the first days, and the maximum duration of the outbreak was 12 days (4–6 times longer than the mean incubation period of shigellosis). It could be assumed that a first wave of cases due to contaminated water was followed by some cases due to person-to-person contamination.

It is also clear that the young had higher attack rates, and old people more severe gastro-enteritis. High attack rates among young people and children during an outbreak related to *S. sonnei* have been reported in other studies. This could be explained by a lower degree of natural immunity to shigellosis, as well as to frequent contacts among children [3, 18].

This study suggests that the outbreak seems to be related to severe and prolonged negligence in the control of the water system of the community. The well was situated near a milk factory and some residences outside the village, and the water system was not regularly controlled.

The impact on the community was important, as the outbreak of gastro-enteritis affected more than 10% of the inhabitants. The epidemic was controlled after simple environmental measures had been taken, but most people required medical attention and some

of them were hospitalized. The study suggests that contaminated water can be the cause of an important shigella epidemic even in a community situated near an urban agglomeration, where environmental hygiene measures are regularly taken in order to minimize the chances of a waterborne outbreak. It is important to emphasize the value of chlorination, as well as of surveillance, in preventing such waterborne outbreaks.

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