Epidem. Inf. (1989), **103**, 133–141
Printed in Great Britain

Waterborne outbreak of campylobacter enteritis after outdoors infantry drill in Utti, Finland

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(*Accepted 14 March 1989*)

SUMMARY

Diarrhoea, abdominal pain, malaise and fever affected 75 of the 88 conscript soldiers in Utti, Finland after an outdoors infantry drill. *Campylobacter jejuni*, heat-stable serotype 3/43/59, was isolated from 37 out of 63 men investigated. A clear serological response was evident in the risk group and negligible in the control group. The entire population at risk was interviewed.

The outbreak was associated with the consumption of untreated surface water. *C. jejuni*, heat-stable serotype 3/43/59, was isolated on two occasions from the water source.

INTRODUCTION

Campylobacter jejuni/coli can attack previously healthy people of all ages in developed countries (Skirrow, 1977; Svedhem & Kaijser, 1980; Pitkänen *et al.* 1983). *Campylobacter* sp. can also be found in the gastrointestinal tract of a great many wild and domestic animals (Lior, 1984). Most campylobacter cases occur sporadically, but substantial outbreaks have also been reported, the largest being associated with contaminated water (Menzing, 1982; Vogt *et al.* 1982; Rogol *et al.* 1983).

Unchlorinated or poorly chlorinated surface water has been epidemiologically implicated as the source of the organisms in some epidemics (Tiehan & Vogt, 1978; McNeill *et al.* 1981; Gondrosen *et al.* 1985; Broczyk *et al.* 1987), and more unusual associations such as with pipeline repairs (Mentzing, 1982; Taylor, Brown & McDermott, 1982; Rogol *et al.* 1983) and heavy rainfalls (Taylor, Brown & McDermott, 1982; Gondrosen *et al.* 1985) have also been reported.

Waterborne outbreaks of campylobacter enteritis are usually large, affecting from 10–20% of the population at risk (Mentzing, 1982; Vogt *et al.* 1982). Most cases occur during the first 2 weeks of the epidemic, but outbreaks have extended over periods of 3 months (Blaser, Penner & Wells, 1982).

Taylor, Brown & McDermott (1982) and Taylor *et al.* (1983) have reported a summertime campylobacter enteritis outbreak among persons who had been hiking in wilderness areas in Grand Teton National Park, Wyoming. The

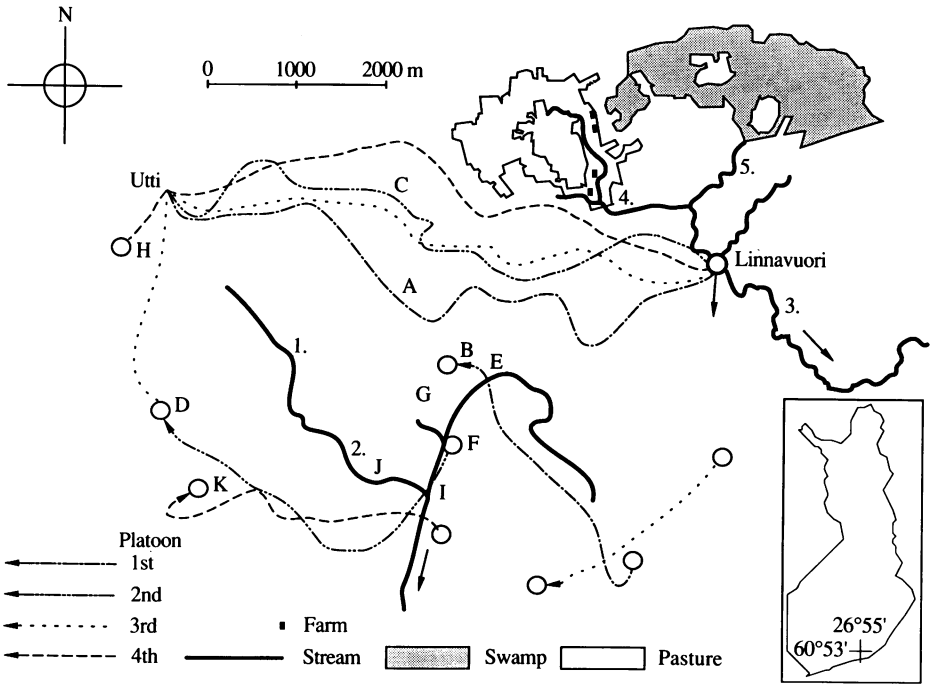

Fig. 1. A schematic map over the area of the outdoors infantry drill of a paratroop unit in Utti, Finland on 22–23 July 1987. Four platoons oriented clockwise from Utti and back following the routes marked by different lines. There is a gap in these lines at places where men oriented in pairs in terrain. Places where men drank unboiled surface water are marked by letters from A to K. The place for the common dinner on 22 July at 6.00 p.m. was at Linnavuori. Places where water samples were taken are marked with numbers from 1 to 5. Linnavuori was also a sampling place. See text for details.

epidemiologically implicated source of campylobacter was surface water. Hopkins, Olmsted & Istre (1984) reported that drinking water, especially amongst campers, was an important risk factor in *Campylobacter jejuni* infection in the summer of 1981 in Colorado.

We report here an outbreak of campylobacter enteritis among conscript soldiers after an outdoors infantry drill. The whole population at risk was interviewed. In this outbreak there was both epidemiological and microbiological evidence implicating surface water as the source of the bacteria.

OUTBREAK

A total of 88 conscript soldiers from a paratroop unit of 107 men took part in an outdoors infantry drill. Men were 18–22 years of age and they were in excellent physical condition. The manoeuvres began in the afternoon of 22 July, the warmest day of the summer 1987 (25–30 °C), and lasted till the next morning. Soldiers divided in four platoons marched from Utti garrison approximately 8 km in difficult terrain to Linnavuori in full marching kit (Fig. 1). After the march there was a common dinner at Linnavuori at 6.00 p.m. After dinner the platoons

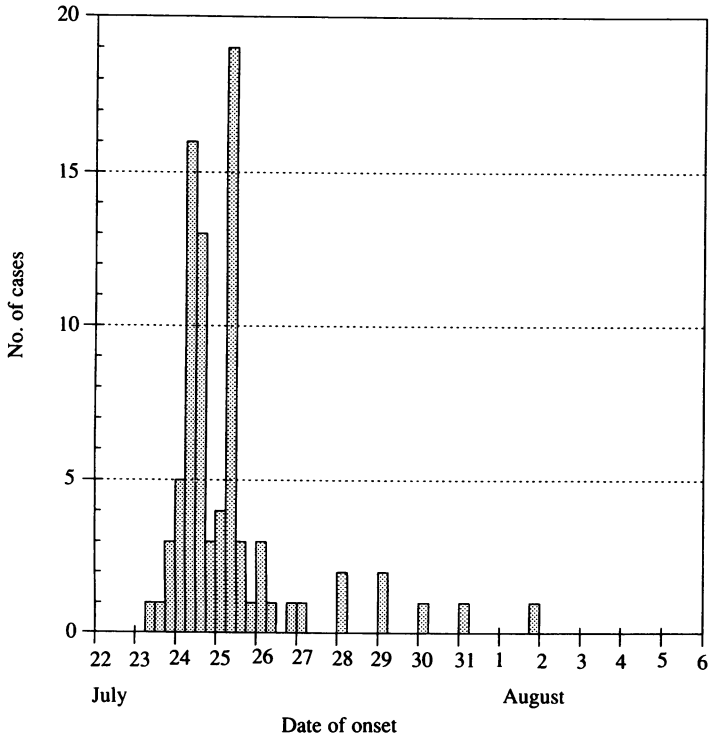

Fig. 2. Onset of symptoms in a waterborne campylobacter outbreak in Utti, Finland, July–August 1987. Contaminated surface water exposure on 22 July at 6.00 p.m.

were divided into smaller groups which gathered at their individually specified gathering points. From these gathering points united platoons oriented to places where men stayed overnight in the open. Orienting in small groups, gathering to specified points and marching back to the barracks continued the next day. The route after the dinner was approximately 17 km (Fig. 1).

Only individually packed pasteurized food was used during manoeuvres. Packages from the same manufacturing lot were checked and were found to be neither damaged nor spoiled. Against regulations untreated surface water was used as drinking water and for making food. During dinner a common water source was used, a stream with clear and rather cold water at Linnavuori. Due to the heat and hard march each man consumed up to 4 l of surface water before dinner. A further 11 water sources were used by only one or two platoons each.

Two days after the manuoeuvres over 60 soldiers fell ill with diarrhoea, abdominal pain or fever. The explosive character of the outbreak indicated a common source (Fig. 2).

SURVEY

All 88 soldiers who took part in the outdoors infantry drill on 22–23 July and 12 soldiers who did not take part in the drill but belonged to the same paratroop unit were interviewed for the first time on 27–29 July and again on 5 August. In addition, 25 soldiers belonging to another unit but living and eating in the same garrison were interviewed as a control group.

Table 1. *Attack rates by exposure to possible activities associated with waterborne campylobacter epidemic in Utti, Finland, July–August 1987*

Activity	Case* Ill‡	Case* Not ill‡	Case* Attack rate (%)	Control* Ill‡	Control* Not ill‡	Control* Attack rate (%)	P†
Belonging to the paratroop unit	79	21	79	0	25	0	< 0·0001
Being present at Linnavuori	75	13	85	4	8	33	< 0·00031
Drinking water at							
Point A§	5	1	83	10	7	59	N.S.‖
Point B	2	0	100	13	8	62	N.S.
Points C, D	8	0	100	13	1	93	N.S.
Points E, F	15	0	100	6	1	86	N.S.
Point G	2	0	100	13	8	62	N.S.
Point H	17	0	100	22	1	96	N.S.
Point I	22	3	88	17	1	94	N.S.
Being present at							
Points J, K	16	0	100	59	13	82	N.S.

* Case with the activity, control without the activity.
† Probability values determined using Fisher's exact test.
‡ Number of persons.
§ Location see Fig. 1.
‖ Not significant.

Seventy-five of the 88 soldiers (85%) who took part in the drill had symptoms as did 4 of the group of 12 soldiers (33%) mentioned above. None of the control group soldiers had any symptoms.

The illness lasted for 1–10 days (median 2·7 days). Attack rates by possible vehicles of infection showed a significant correlation with the consumption of surface water from a stream at Linnavuori (Table 1). The quantity of water ingested did not correlate with the severity of the symptoms.

The time of single exposure to contaminated water was ascertained to be the dinner at Linnavuori. Thus the median incubation period for any kind of symptoms was 72 h (81 ± 4 h)*, for diarrhoea 2 days (3·3 ± 0·3 days), for abdominal pain 2 days (2·7 ± 0·2 days) and for fever 3 days (2·8 ± 0·14 days). Patients did not report bloody or mucous diarrhoea, arthralgia, urinary disturbances or reactions in the skin or in the eyes.

After the drill faecal samples for *Salmonella* spp., *Shigella* spp., *Yersinia enterocolitica* and *Campylobacter* spp. cultures were taken from 3 patients after 6 days, from 58 patients after 9 days and from 5 patients after 12 days. *Campylobacter jejuni*, heat-stable serotype 3/43/59, was isolated from altogether 37 of the 63 patients for whom the cultures were performed. No other pathogens were detected. Strains isolated were serotyped by the passive hemagglutination technique according to Penner & Hennessy (1980). Red blood cells were coated with boiled saline extracts made from each patient strain. They were tested

* Mean ± standard error of the mean in parentheses.

Table 2. *Positive serological responses* of conscript soldiers according to the symptoms and stool culture results in a waterborne campylobacter outbreak in Utti, Finland, July–August 1987*

Stool culture	With symptoms, Patients	No symptoms	
		Exposed soldiers	Controls
Positive	32 (37)†	0 (0)	0 (0)
Negative	1 (18)	0 (2)	0 (8)
Not done	1 (3)	0 (1)	0 (17)
Total	34 (58)	0 (3)	0 (25)

* Elevated campylobacter antibody titres in IgG, IgM and/or IgA classes and fourfold or greater antibody titre changes in consecutive sera.

† Total number of conscript solders from whom sera were available in each group in parentheses.

against known serotype-specific antisera. Eight faecal samples were taken from the control group and all were negative for bacterial pathogens.

Campylobacter antibodies of IgG, IgM and IgA classes were determined by enzyme immunoassay (Rautelin & Kosunen, 1987) in the sera of 61 patients who had taken part in the outdoors infantry drill, in the sera of 6 conscript soldiers who had not taken part in the drill but belonged to the same paratroop unit, and in the sera of 25 controls. In addition 27 soldiers had the first serum taken immediately after the drill (on 23 July) at blood donation. Two to four consecutive serum samples were taken from each of the soldiers. The cut-off for positive serological levels were defined such that 99% of healthy blood donors remained negative, thus giving the test a specificity of 99% (Rautelin & Kosunen, 1987).

A total of 32 out of 37 patients with positive stool cultures had positive serological responses as well. In addition to these one patient with negative stool culture and one patient whose stool culture had not been studied showed serological evidence of campylobacteriosis (Table 2). Neither the controls nor those 6 soldiers who had stayed at the barracks during the drill had elevated campylobacter antibody titres or significant antibody titre changes in consecutive serum samples. All patients with positive campylobacter serology had significant titre changes in consecutive sera.

STUDIES ON THE SOURCE OF THE CONTAMINATION

One 100 ml water sample from a stream at Linnavuori and two samples from Kiikunjoki stream (nos. 1 and 2, Fig. 1) were taken both on 24 July and on 29 July. Standard indicator bacteria, faecal coliforms, total coliforms and faecal streptococci were all > 300 c.f.u./100 ml.

Another three water samples of 1 l were taken for *Campylobacter* spp. examination on 31 July from a stream at Linnavuori, the same place as before, 0·5 km downward the stream at point no. 3 and from Kiikunjoki at point no. 1 (Fig. 1). Temperature of the stream water at Linnavuori was approximately 5 °C at the time of sampling. *Campylobacter jejuni*, heat-stable serotype 3/43/59, was

isolated from the sample taken at Linnavuori. The other two samples were negative for *Campylobacter* spp.

On 6 August three water samples of 1 l were taken from Linnavuori and from the upstream branches of the stream (nos. 4 and 5, Fig. 1). The water sample taken at Linnavuori, at the same place as before, was this time negative for *Campylobacter* spp. One branch of the stream flows through a small agricultural village. In the village there were four farms with animals, which were able to reach the stream while on pasture. Faecal samples were taken from 14 cows, 12 hens and 2 horses on 11 August. All 28 samples proved to be negative for *Campylobacter* spp. Further, the water sample (no. 4, Fig. 1) from this branch was negative for *Campylobacter* spp. The other branch comes from a uninhabited and trenched swamp of approximately 4 km^2 in which there was no pasture. *Campylobacter jejuni*, heat-stable serotype 3/43/59, was isolated from the water sample (no. 5, Fig. 1) taken from this branch. Eight common teals (*Anas crecca*) and 7 mallards (*Anas platyrhynchos*) were shot on 15 and 16 August by the hunting club of the nearby garrison at a pond 30 km north of the swamp. Caecal contents were examined for campylobacter. *Campylobacter jejuni*, heat-stable serotype 31, was isolated from one teal.

DISCUSSION

In this epidemic 75 conscript soldiers of a paratroop unit of 88 men had gastrointestinal symptoms after an overnight infantry drill. *Campylobacter jejuni*, heat-stable serotype 3/43/59, was isolated from 37 out of the 63 men investigated and also twice from the surface water source used during the drill. Symptoms were similar to those reported in other outbreaks (Mentzing, 1982; Vogt *et al.* 1982; Rogol *et al.* 1983; Sacks *et al.* 1986). Those patients from whom campylobacter were isolated had a more severe illness than those who were ill but were culture negative (Fig. 3).

Heat-stable serotype 3, isolated in this epidemic, occurs but it is not among the most common campylobacter serotypes in Scandinavia (Kaijser & Sjögren, 1985; Melby *et al.* 1985; Kosunen, unpublished data). Blaser, Penner & Wells (1982) reported one small person-to-person epidemic caused by this serotype. Heat-stable serotypes 4 and 23 have more often been associated with water epidemics.

The serological survey proved to be useful in this outbreak showing no responses in any of the controls, and high proportion of clear responses in symptomatic patients. In general, the serological results corresponded to our previous findings in campylobacter outbreaks (Rautelin & Kosunen, 1987). A special feature of this survey was that some of the conscript soldiers had the first serum sample taken immediately on the following day after the drill at blood donation, thus providing a good basis for the comparison of the antibody titres of consecutive sera. In this study all patients with elevated campylobacter antibody titres, including those who had not attended the blood donation, had at least fourfold or greater antibody titre changes in consecutive sera.

In vitro studies have demonstrated that *Campylobacter* sp. remain viable for months in surface water at 4 °C, and appear to survive best in water obtained from high mountain streams (Blaser *et al.* 1980; Gondrosen, 1986). *In vivo* recovery rates have been highest in fall and winter months (Carter *et al.* 1987) or in late fall

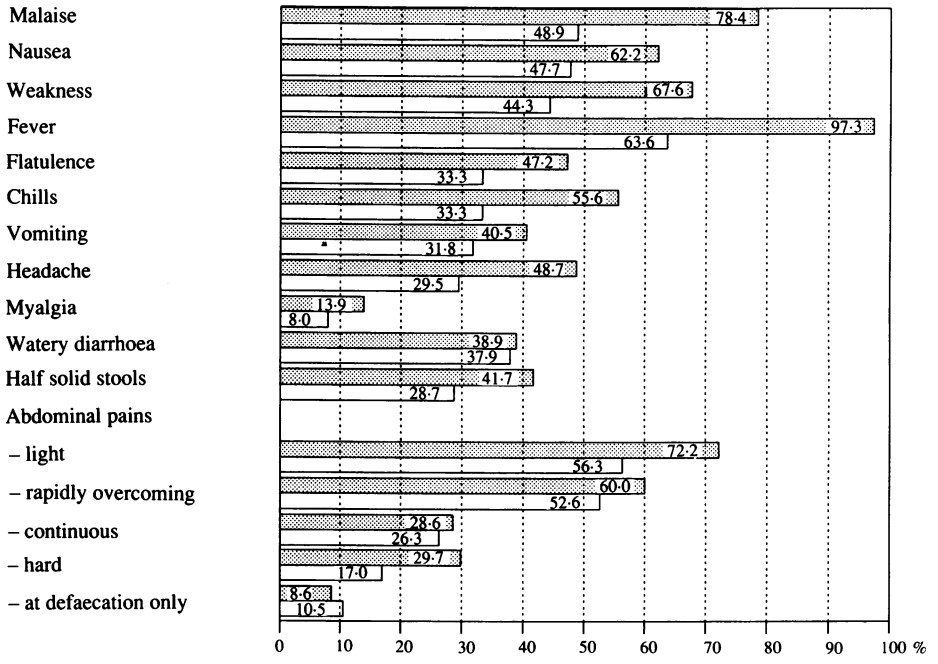

Fig. 3. Percentage of conscript soldiers reporting varous symptoms in a waterborne outbreak in Utti, Finland, July–August 1987. ▨, Only 37 campylobacter-positive soldiers; □, all 88 soldiers who took part in the drill.

and winter (Bolton *et al.* 1987) when the water is cold. In this outbreak either the *Campylobacter* sp. survived in the cold water of the stream for 2 weeks, or there was a continuous source of the organisms upstream.

While some have found campylobacters regularly from many surface waters (Knill, Suckling & Pearson, 1982; Taylor, Brown & McDermott, 1982; Pearson *et al.* 1985; Bolton *et al.* 1987) but others have not (Perkins-Jones, Holman & Frost, 1982). There is evidence of faecal contamination in water when campylobacter are present (Knill, Suckling & Pearson, 1982) as in this study, but correlation with faecal indicators is not clear (Perkins-Jones, Holman & Frost, 1982; Carter *et al.* 1987), possibly due to the relatively low numbers of campylobacters in water. Reisinger (1985) reported that the concentration of campylobacters proved to be highly dependent upon water temperature and also on the presence of waterfowl.

After this outbreak we isolated *Campylobacter jejuni*, heat-stable serotype 31, from one common teal (*Anas crecca*) demonstrating a possible source of the contamination of the stream in the uninhabited swamp.

This outbreak shows clearly the importance of treating all surface water used for human consumption even in clear and cold stream waters.

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