EMERGING *SALMONELLA* ENTERITIDIS ANAEROGENIC PHAGE TYPE 14B: OUTBREAK IN NORWEGIAN, SWEDISH AND FINNISH TRAVELLERS RETURNING FROM GREECE

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In July 2001, the Norwegian Institute of Public Health (Folkehelseinstituttet, FHI) reported a cluster of *Salmonella* Enteritidis of phage type 14b infections in Norwegian travellers returning from Greece. An increase in the same uncommon phage type was also registered in Sweden and Finland at the same time. Cases of *S.* Enteritidis PT 14b in patients returning from Greece were reported in these three Nordic countries in 2001 (303 cases), 2002 (164 cases) and 2003 (199 cases). Case-control studies performed in 2001 in Norway and Sweden indicated that consumption of chicken was associated with illness. In 2002 and 2003, continuing case reports indicated that this uncommon phage type had probably become established in the Greek food chain. Tour operators were informed and contacts were made with Greek public health authorities. Because place of infection is not systematically included in most *Salmonella* notification systems, the *S.* Enteritidis phage type 14b outbreak reported here may represent only part of a larger outbreak among travellers visiting Greece. Infections are often reported only in the tourists' home countries and public health authorities in the tourist destinations may not be aware of the problem. Further collaboration between national institutes of public health in Europe is needed to detect outbreaks occurring among tourists.

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Introduction

Salmonellosis is a disease of considerable clinical and public health importance. In the 1980s, public health authorities in Europe and America noted a considerable increase in human foodborne illnesses caused by *Salmonella enterica* serovar Enteritidis [1,2]. This increase was caused predominantly by strains of phage type (PT) 4 in Europe, and PT 8 and 13 in the United States and Canada [3]. Epidemiological and environmental studies have most commonly implicated eggs and poultry products as risk factors for these infections [4-6].

In July 2001, the Norwegian Institute of Public Health (Folkehelseinstituttet, FHI) had received an unusually high number of notifications of *S.* Enteritidis infections in Norwegian travellers returning from Greece [7]. The national reference laboratory for enteropathogens at NIPH noticed a cluster of cases infected with atypical *S.* Enteritidis. Unusually, all the strains isolated from these patients were anaerogenic (*S.* Enteritidis PT 14b). The Swedish Institute for Infectious Disease Control (Smittskyddsinstitutet, SMI) and the National Institute of Public Health in Finland (Kansanterveyslaitos, KTL) also noticed an increase in the number of *S.* Enteritidis PT 14b infections in travellers returning from Greece in the same time period.

Here we describe the detection of an emerging *S.* Enteritidis subtype using surveillance data from travellers. To obtain an overview of the epidemiological setting, we calculated an annual risk per 100 000 travellers of *S.* Enteritidis reported in Norway, Sweden and Finland in travellers to Greece, from 1997 to 2003. During the outbreak in 2001, we performed two focused case-control studies among Norwegian and Swedish travellers to Crete, the most frequently visited tourist destination, to identify potential outbreak vehicles. Combined, these two approaches describe the impact and potential sources of infection of the largest outbreak of *S.* Enteritidis PT 14b reported in the literature.

Materials and methods

Surveillance system

Salmonella infection is mandatorily reportable to national communicable diseases surveillance systems in Norway, Sweden and Finland, and isolates from local laboratories are routinely forwarded to national reference laboratories (NRL). In Sweden and Finland, all *Salmonella* Enteritidis are phage typed, while in Norway, phage typing is performed on selected strains only when considered necessary for epidemiological reasons.

Analytical study design

Descriptive analysis 1997 – 2003

Surveillance data were compiled from Norway, Sweden and Finland of *Salmonella* infections reported to be acquired after travelling to Greece within the incubation period for *Salmonella* for the period January 1997 and December 2003.

We calculated an annual risk per 100 000 travellers of *S.* Enteritidis and *S.* Enteritidis PT 14b or anaerogenic *S.* Enteritidis infections associated with a travel to Greece and reported in Norway, Sweden and Finland, from 1997 to 2003. For the denominator, data on the number of travellers to Greece from Norway, Sweden and Finland were collected through the national civil aviation in Norway [8], Sweden [9] and Finland [10]. Numerator data consisted of all cases meeting the following case definition.

A case was defined as a human infection notified in Norway, Sweden or Finland with a microbiologically confirmed finding of *Salmonella* Enteritidis after travel to Greece within the incubation period for salmonellosis, with symptom date between 1 January 1997 and 31 December 2002.

Epidemiological investigation of the 2001 outbreak

The first contact with the Greek public health authorities took place on 13 September 2001. Regular contacts were maintained during the entire investigation.

- **Case definition of the studies from 2001:**

An outbreak-associated confirmed case was defined as a person notified in Norway, Sweden or Finland with a microbiologically confirmed finding of *S.* Enteritidis phage type 14b after travel to Greece within the incubation period for salmonellosis, with date of symptoms between 1 May and 31 December 2001. Since Norway did not phage type all *S.* Enteritidis isolates, an outbreak-associated probable case was defined as an infection notified in Norway with a positive finding of an anaerogenic *S.* Enteritidis, after travel to Greece

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within the incubation period for salmonellosis, occurring between 1 May and 31 December 2001.

Two case-control studies were conducted independently in Norway and Sweden to identify potential vehicles of the outbreak. To facilitate the epidemiological investigation, the case-control studies were limited to travellers who visited Greece, but who spent a part of their trip in Crete, the region with the greatest number of tourists from Norway and Sweden. Different methodological approaches are described below.

• **Pilot study**

Starting on 3 September 2001, a pilot study among 40 Norwegian travellers was performed by telephone interviews using a standardised questionnaire. Information was obtained on demographic details, place of stay, tour operators, airline companies, food consumed during the three days before onset of symptoms and names of restaurants visited. Results of the pilot study were shared between national institutes. As the pilot interviews did not give any hypothesis to test in a case-control study, we decided to focus our questionnaire on the most likely vehicles of *S.* Enteritidis, eggs and meat. Meals containing either eggs or meat that were likely to be available in Greece were listed. These included well-known main dishes served in restaurants in tourist areas (based on information given by local tour operators), and were included in the questionnaires for the case-control studies. Only outbreak associated cases were included in the case-control studies.

• **Case-control study in Norway**

Addresses and telephone numbers of the first 45 notified cases with anaerogenic *S.* Enteritidis were obtained. A standardised questionnaire was mailed to this group of cases (16 October 2001). The case-control study was limited to the group of cases, over 15 years of age, who stayed in Chania district, Crete, between 9 July and 2 September 2001. Three controls per case were matched among travellers who used the same tour operator to visit Greece in the same period of time (+/- one week).

• **Case-control study in Sweden**

The case-control study was limited to the group of patients who stayed in Crete and whose infections were notified to the Swedish infectious disease surveillance system between 1 September and 15 November 2001. Only people over 20 years of age were included. Controls were selected by tour operators from people who had travelled to the same destination during the same time period. Information from both cases and controls was collected by a postal questionnaire similar to the one used in the study in Norway. Additional questions regarding food served on the flights were also included. Due to the long time lapse between the outbreak and distribution of the questionnaires, and potential recall bias, it was not considered feasible to collect data on food consumed on the individual dates. Cases were therefore asked about food consumption in Crete before falling ill (three days before onset of symptoms), and controls were asked about food consumption during their stay abroad.

Laboratory investigations

Isolates from patients were characterised by standard biochemical and serological assays at the reference laboratories. The Norwegian reference laboratory routinely tested formation of gas during fermentation of D-glucose after overnight incubation of tubes at +35oC in ambient air. Strains that did not produce gas from D-glucose were called anaerogenic. The anaerogenic property was also tested on a random number of strains at SMI. The antimicrobial susceptibility was routinely tested on Norwegian and Finnish isolates. Phage typing was performed on all strains in Sweden and Finland, and for a selected number of strains in Norway.

Analysis

Data was analysed using *SPSS* version 10.0 (SPSS Inc, Chicago, IL, USA). Food specific odds ratios (OR) and 95% confidence intervals (95% CI) were calculated for the consumption of food items. The _ 2 test was used to compare proportions between groups (5% significance level). Exposures significantly associated with infection by univariate analysis ($p<0.1$ or $OR > 3$) were included in a multivariable logistic regression model (*LogXact* statistical software; Cytel Statistics and Epidemiology Research Corporation, Seattle, WA, USA). The final model was obtained through stepwise deletion of variables on the basis of statistical and epidemiological criteria.

Results

Surveillance data from 1997 to 2003 of Salmonellosis after travelling to Greece

From 1997 to 2000, *S.* Enteritidis infections represented an average of 61% of all *Salmonella* infections associated with a travel to Greece (mean of 244 cases per year, standard deviation of 40). However, a sharp increase of *S.* Enteritidis infections was observed in 2001, with 569 cases [TABLE 1]. Since non-outbreak strains remained at a constant level, the outbreak strain appeared to be the cause of the increased number of cases of *S.* Enteritidis [FIGURE 1].

FIGURE 1

Compiled data of Salmonella Enteritidis infections associated with travel to Greece reported in Norway, Sweden and Finland, 1997-2003

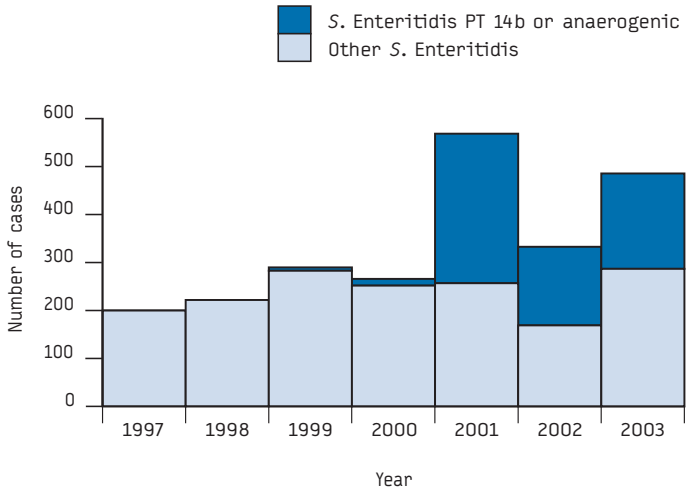


TABLE 1

Annual distribution of numbers of travellers to Greece and of *Salmonella* Enteritidis infections associated with travel to Greece reported in Norway, Sweden and Finland, 1997-2003

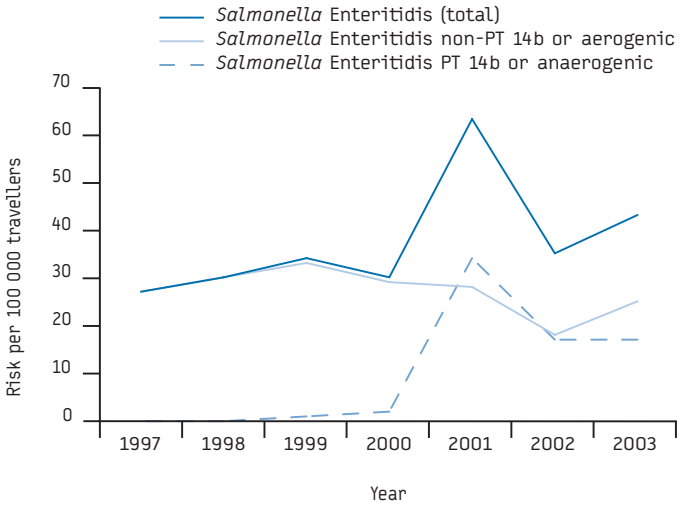
Years	1997	1998	1999	2000	2001	2002	2003
Total number of travellers to Greece*	740 870	731 597	844 901	875 010	909 966	955 996	1 138 155
All *Salmonella*	339	362	464	445	735	422	563
Proportion of *S.* Enteritidis/all *Salmonella*	59%	61%	63%	60%	77%	79%	86%
S. Enteritidis non-PT 14b or aerogenic	200	222	283	252	257	169	287
S. Enteritidis PT 14b or anaerogenic	0	0	7	14	303	164	199
Total *S.* Enteritidis	200	222	290	266	560	333	486

* Source: National civil aviation statistics bureaux of Norway, Sweden and Finland

The total number of travellers from Norway, Sweden and Finland visiting Greece increased from 740 000 in 1997 to 1 138 155 in 2003 [8,9,10]. Reported cases of *S.* Enteritidis in travellers increased dramatically in 2001, but was entirely due to the increased incidence of *S.* Enteritidis PT 14b [FIGURE 2].Compared with 2001, we observed a decreased number of *S.* Enteritidis PT 14b associated with travel to Greece in 2002 and 2003.

FIGURE 2

Risk of *S.* Enteritidis and *S.* Enteritidis PT 14b or anaerogenic infections per 100 000 travellers associated with travel to Greece and reported in Norway, Sweden and Finland, 1997-2003



Outbreak investigation in 2001

• **Descriptive findings**

The first case was a Swedish tourist who fell ill on 27 May 2001. By 31 December 2001, 303 cases had been reported in Norway, Sweden and Finland: 89 in Norway (49 confirmed cases and 40 probable cases); 149 in Sweden; and 65 in Finland. The median age was 35 years and the male:female sex ratio was 0.9.

The distribution of cases by week of symptom onset showed two peaks in each country [FIGURE 3]; the first in week 33 (from 13 to 19 August); and second in week 41 (from 8 to 14 October), corresponding to the summer and autumn school holidays.

Fifty one per cent of the patients (n=154) had only visited Crete and were suspected to have been infected there, but cases also occurred in various other tourist locations in Greece: 36 cases in Rhodes (12%), 17 cases in Kos (6%), 8 cases in Karpathos (3%), 4 cases in Samos, 3 cases in Corfu, 2 cases in Skiathos, 1 case in Athens and 1 case in Paros. For the remaining 77 cases (25%), the exact place in Greece was not specified.

• **Laboratory findings**

All cases had culture-confirmed finding of *S.* Enteritidis. All isolates (n=154) were sensitive to all antimicrobials tested (trimethoprim-sulfamethoxazole, chloramphenicol, tetracycline, ampicillin, nalidixic acid and ciprofloxacin). Ninety eight per cent of isolates (65/66) confirmed to be *S.* Enteritidis PT 14b in Norway and Sweden and related to travel to Greece were anaerogenic.

• **Results of the case-control studies**

There were some methodological differences between the Norwegian and Swedish studies, and so results are presented separately.

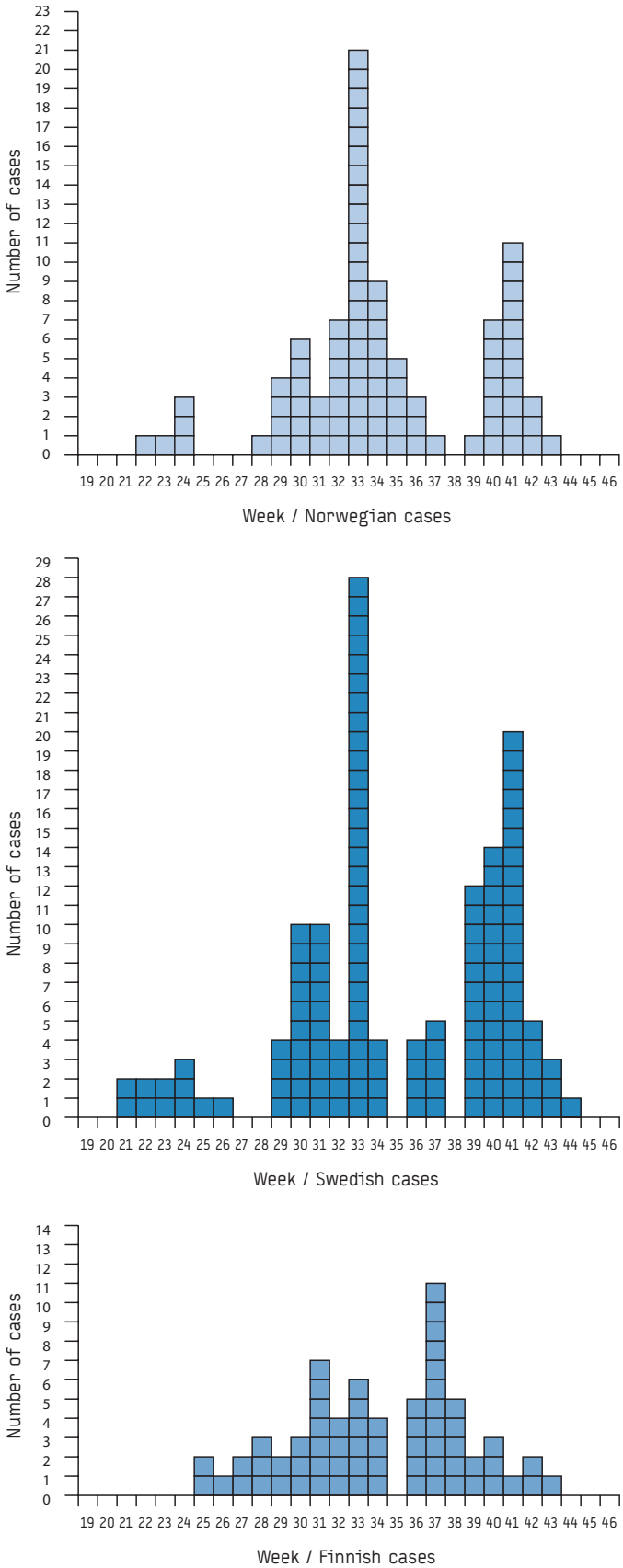
Study performed in Norway: 25 cases and 46 controls were enrolled in the study. In univariate analysis, two exposures were statistically associated with risk of illness [TABLE 2]. Sixty three per cent of the cases and 33% of the controls ate chicken in the three days before onset of symptoms (matched OR 3.4; 95% CI 1.2 to 9.7). Thirty three per cent of the cases and 13% of the controls ate hamburger (matched OR 3.3; 95% CI 1.0 to 11.1).

In a multivariable analysis using a model containing chicken and hamburger, only chicken remained significantly associated with illness (OR=3.3; 95% CI 1.0 to 11.3).

Study performed in Sweden: 24 cases and 33 controls were enrolled in the Swedish study. No significant associations were found for food items consumed during the stay in Crete. Chicken consumed during the stay in Greece was not associated with disease.

FIGURE 3

Distribution of cases of *S.* Enteritidis phage type 14b among Scandinavian travellers returning from Greece, by week of symptom onset and place of suspected infection, Norway, Sweden and Finland, May-December 2001



When food consumed on the flight (from Greece to Sweden) was analysed separately, chicken was found to be associated with infection (OR 3.4; 95% CI 0.7 to 18.8). When cases were divided into cases falling ill in Crete, and cases falling ill after returning to Sweden, chicken served on the return flight was associated with disease (OR 7.9; 95% CI 1.0 to 74.2) [TABLE 3].

Discussion

This is the largest outbreak of *S.* Enteritidis PT 14b reported in the literature. The emergence of this unusual phage type 14b in Greece has been detected through the communicable disease surveillance of travellers in three of the Nordic countries. Results of the case-control studies suggest that chicken was the probable vehicle of the 2001 outbreak. It is likely that other sources should be considered, because continued case reports in 2002 and 2003 suggest that this phage type might have become endemic in this region.

The results of the case-control studies conducted in 2001 suggested that chicken was the likely vehicle of transmission, as is very often reported for *S.* Enteritidis infection. There are several data and methodological limitations in the case-control studies which should be noted. Not all cases reported having consumed chicken, but this meat is sometimes used in salads, souvlaki, pizza or other meals, and there is also the risk of food contamination in the food chain. The delay between onset of symptoms and the investigation may have caused recall bias that may have weakened the significance of this finding. Environmental investigations could have strengthened our findings, but were not conducted. Further, the limited sample sizes available for the case-control studies in both Norway and Sweden limit our ability to draw strong conclusions.

In this outbreak, the first peak of cases was observed in mid-August, corresponding to the summer school holidays in Nordic countries, and a second peak in mid-October corresponding to the autumn school holidays. Greece is a popular holiday destination and the season is limited to the period between May and November. The high number of cases in people who had stayed in Crete may party reflect the higher proportion of tourists visiting the island.

The decrease in the number of cases observed in 2002 and 2003, for all *S.* Enteritidis infections, may be a consequence of the information given by Nordic public health institutes to travellers to Greece and/or measures taken by Greek authorities. Collaboration with tour operators has been an important channel of information. Additionally, reports of the 2001 outbreak in the media may have contributed to an increased awareness of travellers about raw or insufficiently cooked food.

The Nordic surveillance systems have also recorded sporadic infections with anaerogenic *S.* Enteritidis PT 14b after travel to Italy, Bulgaria and Spain. However, the number of cases associated with travel to other European countries remains largely low when compared with the number of cases associated with travel to Greece. *S.* Enteritidis PT 14b was responsible for an outbreak in Spain in early 2001 [11] and for an outbreak in the United Kingdom (UK) in 2002 [12]. Because of homogeneity in *S.* Enteritidis of the same phage type, conventional PFGE using *Xba*I restriction enzyme was not able to differentiate these strains from the strains related to the outbreak in Greece. However, strains isolated in the UK were aerogenic [13],

TABLE 2

Frequency of selected exposures among cases and controls, S. Enteritidis phage type 14b infection in Norwegian travellers returning from Crete, July-September 2001

Food consumed*	Case patients			Control subjects			Odds ratio	95% CI
	No.	%	Total*	No.	%	Total*		
Egg products								
Soft boiled egg	0	0	24	7	15	46	Undefined	-∞ – 1.4
Hard boiled egg	2	8	24	2	4	46	2.0	0.3 – 15.2
Fried egg	3	13	24	8	17	46	0.7	0.2 – 2.8
Omelette	7	29	24	13	28	46	1.0	0.3 – 3.1
Scrambled egg	0	0	24	2	4	46	Undefined	-∞ – 8.1
Custard	0	0	24	2	4	46	Undefined	-∞ – 8.1
Cake with custard	0	0	24	1	2	46	Undefined	-∞ – 34.4
Béarnaise sauce	5	21	24	5	21	46	2.2	0.6 – 8.4
Rémoulade	0	0	24	2	4	46	Undefined	-∞ – 8.1
Other egg products	4	19	21	4	9	46	2.5	0.6 – 11.0
Meat products								
Chicken	**15**	**63**	**24**	**15**	**33**	**46**	**3.4**	**1.2 – 9.7**
Pork	5	21	24	17	37	46	0.4	0.1 – 1.4
Beef	6	25	24	21	46	46	0.4	0.1 – 1.2
Lamb	6	25	24	14	30	46	0.8	0.2 – 2.3
Souvlaki	6	25	24	16	35	46	0.6	0.2 – 1.9
Beef fillet	5	21	24	15	33	46	0.5	0.2 – 1.7
Meatballs	0	24	24	5	11	46	Undefined	-∞ – 2.5
Hamburger	**8**	**33**	**24**	**6**	**13**	**46**	**3.3**	**1.0 – 11.1**
Pizza	10	42	24	17	37	46	1.2	0.4 – 3.3
Pasta	5	21	24	5	11	46	2.2	0.6 – 8.3
Moussaka	4	17	24	10	22	46	0.7	0.2 – 2.6
Kebab	2	8	24	2	4	46	2.0	0.3 – 15.2
Sausage	3	13	24	8	17	46	0.7	0.2 – 2.8
Other meat dish	2	8	25	2	4	46	1.9	0.2 – 14.5

* Food items consumed by neither cases nor controls are not reported

while strains associated with Greece were predominantly anaerogenic. The testing of gas production of *S.* Enteritidis performed routinely at NIPH was a key element in identifying a cluster of cases in Norway. In Sweden and Finland, the cluster of cases was easily detected by phage typing all *S.* Enteritidis isolates.

Detecting emerging diseases through travellers surveillance systems:

The use of the term 'outbreak' in this context may be debatable as the increase in *S.* Enteritidis PT 14b infections in travellers returning from Greece may reflect the recent introduction of this unusual phage type into the Greek food chain. However, from the point of view of national surveillance systems in Norway, Sweden and Finland, the 2001 situation was a real outbreak in travellers. The Nordic surveillance systems had already noted a few cases of *S.* Enteritidis PT 14b infections in 1999 (7 cases) and 2000 (14 cases) [TABLE 1]. This may have been an early alert for the 'explosion' of cases observed in 2001. Identification of even these few cases in 1999 and 2000 could have been used as an opportunity for faster notification and exchange of information to our Greek colleagues, but this information was not transmitted until September 2001.

A key element in detecting the extension of the outbreak was the sharing of information among national public health institutes through Enter-net, the European network for surveillance of salmonellosis, campylobacteriosis, and infection with enterohaemorrhagic *E. coli*. This exchange allowed Norway, Sweden and Finland to pool their data and realise the scope of the problem. Today, increased collaboration between European countries regarding communicable diseases makes it possible to exchange this type of sensitive information. It must be noted that other European countries did not detect such events related to travel to Greece for several reasons: the number of travellers infected (absolute number and relative to their total population) might not have been sufficient to be visible; phage typing is not performed on *S.* Enteritidis strains in most European countries, and this unusual phage type might not have been noticed in numbers important enough at the country scale; probable place of infection is not part of the standard data collection of enteric diseases in most European countries, but is in Norway, Sweden and Finland. This last element explains why these three Nordic countries were able to quickly connect an unusual number of events to a probable place of origin. The sensitivity of the information lies in the fact that publicly disclosing information regarding an outbreak could have dramatic economic consequences for tourism and a country's public image.

TABLE 3

Frequency of selected exposures among cases and controls, *S.* Enteritidis phage type 14 infection among Swedish travellers returning from Crete, September-November 2001

Food consumed *	Case patients			Control subjects			Odds ratio	95% CI
	No.	%	Total*	No.	%	Total*		
Egg products								
Raw egg	0	0	16	1	3	29	Undefined	-∞ – 33.0
Soft boiled egg	3	19	16	5	17	30	1.1	0.1 – 7.1
Hard boiled egg	10	50	20	12	41	29	1.4	0.4 – 5.2
Fried egg	6	33	18	6	27	22	1.8	0.4 – 8.6
Omelette	8	47	17	9	32	28	1.8	0.5 – 7.9
Scramble egg	1	6	16	3	11	28	0.6	0.02 – 7.2
Chocolate mousse	2	13	16	4	14	28	0.9	0.1 – 6.7-
Ice cream	9	53	17	26	87	30	0.2	0.03 – 0.9
Doughnut	9	47	19	16	55	29	0.7	0.2 – 2.7
Cake with custard	3	19	16	6	26	23	0.9	0.1 – 5.1
Béarnaise sauce	6	35	17	13	48	27	0.6	0.1 – 2.4
Mayonnaise	3	21	13	5	19	24	1.9	0.2 – 15.2
Salad with mayonnaise	3	23	14	5	19	26	1.3	0.2 – 8.9
Meat products								
Chicken	14	70	20	23	82	28	0.5	0.1 – 2.4
Chicken - return flight	**12**	**70**	**17**	**7**	**41**	**17**	**3.4**	**0.7 – 18.8**
Pork	21	88	24	27	93	29	0.8	0.1 – 5.6
Beef	16	89	18	27	93	29	0.6	0.1 – 6.8
Lamb	6	38	16	14	52	27	0.6	0.1 – 2.3
Souvlaki	17	77	22	25	83	30	0.7	0.1 – 3.3
Beef fillet	6	46	13	15	56	27	0.7	0.2 – 3.2
Hamburger	7	44	16	10	34	29	1.5	0.4 – 6.3
Pizza	10	56	18	14	47	30	1.4	0.4 – 5.5
Pasta	13	72	18	15	56	27	2.1	0.5 – 9.3
Moussaka	11	58	19	25	78	32	0.4	0.1 – 1.6
Kebab	3	19	16	4	14	28	1.4	0.2 – 9.2
Sausage	5	29	17	8	29	28	1.0	0.2 – 4.8
Other meat dish	1	7	14	5	20	25	0.3	0.01 – 1.6
Cases falling ill after return								
Chicken - return flight	**11**	**85**	**13**	**7**	**41**	**17**	**7.9**	**1.0 – 74.2**

* Food items consumed by neither cases nor controls are not reported

These elements cannot be neglected and should strengthen the European policy to increase public health collaboration between states. In comparison, a similar situation in the United States, would probably have been easily handled between states, under the auspices of the Centers for Disease Control and Prevention (CDC). A mediating structure, the European Centre for Disease Prevention and Control (ECDC) was created in Europe in 2005 [14].

Detection of emerging organisms through infections in travellers returning from abroad has been previously described. These phenomena are especially likely to occur in tourist areas, particularly when the number of travellers is large (the number of Norwegian, Swedish and Finnish tourists visiting Greece was estimated to be about one million in 2001).

Because the place of infection is not included in *Salmonella* notification systems in most countries, it is likely that the *S.* Enteritidis PT 14b outbreak reported in Nordic countries represents only the tip of the iceberg of this outbreak among travellers visiting Greece.

Infections are often reported only in the travellers' home country, because patients often prefer to seek medical care after returning. Therefore public health authorities in the tourist destinations may not be aware of the problem, or not informed until later. Many cases of foodborne illnesses are not reported because patients do not seek medical care, healthcare providers do not obtain specimens for diagnosis, laboratories do not perform the necessary diagnostic tests or illnesses or laboratory findings are not communicated to public health officials. Therefore, to estimate the total number of illnesses caused by each pathogen, the degree of underreporting needs to be taken into account, that is, the difference between the number of reported cases and the number of cases that actually occur in the community. For *Salmonella*, a pathogen that typically causes non-bloody diarrhoea, the degree of underreporting has been estimated up to 38-fold [15-18]. However, it would probably be wrong to use this estimate for this outbreak since patients might choose seek medical care after travelling abroad more often than if infected in their home country. Even with a conservative approach, the number of European travellers infected in Greece may be substantial.

S. Enteritidis infections in humans showed a clear increase in several countries in Europe during the 1980s and early 1990s, and investigations showed that the increase was mainly related to consumption of eggs and poultry [19]. This spread of *S.* Enteritidis within the egg and poultry sector was probably largely facilitated by the intense breeding schemes used in egg producing units. Introduction of *S.* Enteritidis into breeding lines may therefore have contributed to the rapid and wide spread in the egg and poultry sector. A few phage types have dominated among the *S.* Enteritidis strains; mainly PT 4 in Europe and PT 8 and 13a in the US [3]. The detection and investigation of the present outbreak was facilitated by the presence of an atypical (anaerogenic) *S.* Enteritidis, subsequently demonstrated as belonging to a previously uncommon phage type, PT 14b. According to the literature, anaerogenicity is a rare property reported in only 3.9% of *S.* Enteritidis [20]. Our finding is in favour of the emergence of the unusual phage type, retrospectively shown to have started in 1999 and to have 'exploded' in 2001. Cases reported again in 2002 and 2003 further suggest that the phage type may have become established in the food chain, not necessarily only in poultry. This interpretation is supported by the study described by Nygard et al based on Swedish surveillance data [21,22]. In this study, infections in Swedish travellers correlate well with national studies conducted in the countries visited. In 2001 a change in phage type distribution in *S.* Enteritidis infections among Swedish travellers returning from some countries in southern Europe, including Greece was observed, and anaerogenic *S.* Enteritidis PT 14b became one of the most commonly diagnosed that year, continuing into 2002 and 2003.

Problems of food- and waterborne diseases in travellers are well identified. It is an important factor which, unless controlled, can have severe effects on local, national and international trade [23]. Further investigation must be performed to understand why this phage type has suddenly increased in this region, although it had already been present for some years without causing large outbreaks.

The *S.* Enteritidis phage type 14b outbreak reported in Nordic countries may only represent part of a larger outbreak among travellers to Greece. Notification of place of infection has been a key element to detect this outbreak reported among travellers. The Enter-net system has been crucial for sharing of information in Europe. Collaboration among public health institutions should be strengthened, particularly for outbreaks occurring in popular tourist destinations.

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