

immunocompromised patients [2,3,5,7,8]. In our case, the risk factors could be the age of the patient, diabetes mellitus and alcoholism. In 15 of the 23 patients the disease was fatal. The method of inoculation is not clear, although we cannot exclude the possibility of aspiration, as the patient had vomited a few times before admission to the hospital. Although *Bacillus pneumoniae* is rare, it is too often associated with fatal outcome. *Bacillus* species are capable of producing β -lactamases [4] so β -lactam antibiotics would not be effective, but they are very often used in empirical therapy of lower respiratory tract infections [9]. The drug of choice for life-threatening *Bacillus* infections would be vancomycin with or without aminoglycoside [10]. Other effective agents include imipenem, ciprofloxacin, tetracycline, chloramphenicol, clindamycin or macrolide [4,10]. The reported cases show the need for early identification of this unusual pathogen and prompt treatment with appropriate antibiotics to avoid complications and death from *Bacillus cereus* pneumonia.

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Outbreak of diarrhea related to *Clostridium perfringens* in a correctional facility: an epidemiologic investigation

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Current interest in food-borne disease caused by *Escherichia coli* O157, antibiotic-resistant salmonellae and campylobacters sometimes results in our forgetting that other important organisms reach man via food. In addition, it is too often assumed that conventional epidemiology has been rendered obsolete by molecular typing. For these reasons we report an outbreak of diarrhea resulting from contamination of food by *Clostridium perfringens*.

On 7 January 1998, a physician at the correctional facility in Nice, France observed a large number of cases of diarrhea associated with abdominal pain among inmates only. No fever or vomiting was observed. No hospitalization was necessary. A food-borne outbreak was suspected, and our department was called by the local public-health and hygiene administration (DDASS) to perform an epidemiologic investigation. A definite case was defined as: any prisoner present in the correctional facility at least since 5 January, and presenting either with diarrhea or abdominal pain, or both on 6 and/or 7 January. A control was defined as: any prisoner present in the correctional facility at least since 5 January, and presenting neither diarrhea nor abdominal pain, on 6 and/or 7 January.

Menus for 5, 6 and 7 January were provided by the facility's director. All inmates were asked to complete a standard questionnaire concerning symptoms and food intake on these days.

All meals are prepared in the jail kitchen by inmates, under the supervision of one civilian food handler. However, some of the prisoners have enough money to buy their food directly from another food provider, and cook it themselves. Food origin was known, and left-overs from the main meals were available for bacterial cultures. Among inmates who saw the physician at the correctional facility, 11 had stool samples cultured. Samples were cultured at the university laboratory on the usual media for identification of the main gastrointestinal tract pathogens plus two sheep blood-enriched Columbia agar plates, one of which contained kanamycin plus vancomycin. These Columbia agar plates were incubated in anaerobic conditions at 37°C.

Cases were compared to controls with regard to food and beverage consumption from 5 January through

7 January; odds ratios and their 95% confidence intervals were calculated using Epi info software. Potential confounders were accounted for by a stepwise logistic regression (BMDP software).

Ninety-three cases (20 female and 73 male) and 88 controls (14 women and 74 men) were interviewed from 9 January through 12 January. Their mean age was 35 ± 12 years. Cases were spread among three different wings of the facility: A and B for men, and F for women. The total number of prisoners incarcerated on 6 January was 580, and thus the attack rate was 0.16. Diarrhea occurred mostly on 6 and 7 January. Most of the prisoners were referred to the correctional facility physician (77/93, 83%).

There was no difference between cases and controls for variables such as age and beverages. Illness was associated with intake of roast turkey and gravy (OR=7.3, CI 95% 3.14–17.4; OR=6, CI 95% 2.59–14.2) as well as other foods such as tripe, meatballs and pasta with statistically significant odds ratios. In a multivariate analysis, the only statistically significant identified risk factor was roast turkey (OR=6, CI 95% 2.45–14.7).

From 3 January through 3 February 1998, 21 stool samples from ill inmates were analyzed by the bacteriologic laboratory, 11 of them between 6 January and 12 January. Five stool samples of these 11 had high numbers of *Clostridium perfringens*, i.e. more than 10^{10} bacteria/g, in a pure culture in anaerobiosis. For these five strains, genomic analysis performed by PCR at the reference center for anaerobic bacteria (Pasteur Institute [1]) yielded genes for Alpha, Beta 2, Enterotoxin and Theta. Genes for Beta 1, Epsilon, Iota a and Iota b were absent. Strains isolated from later samples had different genomic profiles. The pathogen isolated from the turkey was *Clostridium perfringens*. This strain had the same PCR profile as those isolated from prisoners from 6 January through 12 January. These identical strains also had the same antibiotype. They were resistant to kanamycin and trimethoprim–sulfamethoxazole, and sensitive to other antibiotics. Bacteriologic analysis showed major contamination of the roast turkey with a mesophile flora, suggesting inadequate refrigeration. The roast turkey had 1900 000 microorganisms per gram at 30°C (statutory criteria: 300 000/g), 150 000 coliforms/g (1000/g), and 15 000 thermotolerant coliforms/g (10/g) but less than 10 000 *Bacillus cereus*/g. However, there were no coagulase-negative staphylococci, or *Salmonella* spp. Since fecal organisms were identified in large numbers in the left-overs, the sample did not conform with the standards of French legislation on large-scale food distribution.

Roast turkey was delivered and boiled on 5 January, cooled at room temperature stored in cool cabinets for

the night, and finally sliced and stored at room temperature on the morning of 6 January. The investigation showed that many food containers, especially those devoted to food transportation, were out of order, and none of them were able to maintain a temperature above 65°C. When we visited the jail kitchen, we found it dirty, and noticed many hygiene irregularities, in particular in handwashing.

Results of the epidemiologic study clearly show that roast turkey eaten for lunch on 6 January was responsible for this outbreak of diarrhea. This result is in accordance with that of the bacteriologic study of the left-overs, which yielded *Clostridium perfringens* in that same roast turkey. Among seven different strains of *Clostridium perfringens* isolated during 1 month in our laboratory only the first five are identical to those from the roast turkey, and identical to one another. The last two are unlikely to be responsible for this outbreak. Moreover, they belong to stool samples obtained later, outside the outbreak period. Considering the ecology of clostridia, especially *Clostridium perfringens*, and because of inappropriate hygiene in the facility kitchen, it is likely that food contamination occurred after it was delivered to the facility. Moreover, the presence of fecal flora and mesophile flora both argue in favor of very late contamination, probably during slicing. The dirtiness of the food and the lack of procedures for handwashing also argue for the responsibility of a food handler in this outbreak.

Food-borne outbreaks due to *Clostridium perfringens* continue to be identified. They usually involve red meat, poultry, or sauce as a pathogen vehicle [2,3]. Food-handling errors, especially improper storage and improper refrigeration, are usually reported as the main contributing factors to the outbreak [4]. However, this outbreak is special, because it occurred in a correctional facility. Several food-borne outbreaks in correctional facilities have been reported, especially in the USA [5], but they have led to no fatalities among the prisoners; *Clostridium perfringens* was the second most frequent pathogen, responsible for 34% of the outbreaks. As in the outbreak we investigated, improper storage of food and inadequate hygiene were usually responsible (78%). French legislation on hygiene for large-scale facilities is very strict, although not always respected [6]. After this outbreak occurred, the local public-health and hygiene administration demanded the permanent closure of the kitchen.

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