Multilocus Outbreak of Foodborne Botulism Linked to Contaminated Sausage in Hebei Province, China

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In 2007, an outbreak of foodborne botulism occurred in Hebei province, China. An epidemiological investigation and laboratory detection studies showed that sausage contaminated by type A Clostridium botulinum caused this outbreak of food poisoning. Its clinical and epidemiological features were different from previous reports of food poisoning.

Botulism is a serious foodborne illness caused by Clostridium botulinum, a gram-positive, anaerobic, spore-forming bacterium. C. botulinum strains produce 7 potent neurotoxins (types A–G), of which types A, B, and E cause most cases of botulism in humans [1, 2]. Botulinum intoxication can lead to a classic clinical syndrome of cranial neuropathy and symmetric descending flaccid paralysis, which necessitates mechanical ventilatory support in ~60% of patients [3].

Foodborne botulism is caused by the consumption of food containing botulinum toxin. C. botulinum spores are ubiquitous in the environment, but germination and toxin production occur primarily, although not exclusively, under anaerobic, low-salt, low-sugar, and low-acid conditions at nonrefrigeration temperatures [4]. Storage of a commercial food product that contains C. botulinum spores at an inappropriate temperature can lead to large outbreaks of this potentially fatal disease. Several large outbreaks in recent decades have been associated with commercial foods [1, 5].

Here we report an outbreak of foodborne botulism involving 66 persons, which occurred during the period from 3 August to 20 September 2007 in Hebei province, China. An immediate investigation was conducted to take proper therapeutic measures, interview and identify the persons exposed to the implicated foods, and collect clinical and food samples for laboratory testing. The epidemiological investigation and microbiological testing showed that sausage, which was widely sold in the local community and stored at an inappropriate temperature, was the probable source of the outbreak.

Methods. The first patient presented on 3 August 2007, and the last patient was a 38-year-old man who presented to the local hospital on 20 September 2007. A total of 66 patients were reported to have botulism and were admitted to 9 different hospitals in Hebei province, China (Table 1). A confirmed case of botulism was defined as a person with any objective neurological findings consistent with botulism in whom serum botulinum toxin was detected, or a person who had objective neurological findings consistent with botulism who had consumed food that tested positive for botulinum toxin or had a positive culture. A suspected case of botulism was defined as a person with any objective neurological findings consistent with botulism who had consumed the same food that tested positive for botulinum toxin but for whom the serum toxin test was negative. Clinical and epidemiological investigations were carried out with patients, contacts, clinicians, and all suspected foods. A standard questionnaire survey requesting information on clinical symptoms (eg, headache, nausea, vomiting, and ptosis) and food history was conducted, and each step in the preparation and storage of foods was reviewed.

On the basis of interview results, a case-control study including 66 case patients and 89 control subjects (from households and neighborhoods) was conducted. Odds ratios (ORs) from univariate analysis were calculated by use of maximum-likelihood estimates, including 95% exact confidence intervals (CIs), which were determined by use of the Fisher exact test (Epi Info, version 3.3.2; Centers for Disease Control and Prevention). All of the different brands of sausage suspected of having caused this outbreak of food poisoning were investigated and are listed in Table 2.

Stool, serum, and food samples were obtained from patients and were submitted to the diagnostic laboratory for detection...
Table 1. Laboratory Data on Cases of *Clostridium botulinum* from Different Counties in Hebei Province, China, during the Period from 3 August to 20 September 2007

<table>
<thead>
<tr>
<th>Outbreak location</th>
<th>No. of cases</th>
<th>Serum sample tested positive by use of type A toxin test</th>
<th>Stool sample tested positive by use of type A toxin test</th>
<th>Stool sample tested positive by use of culture</th>
<th>No. of suspected casesb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zhengding county</td>
<td>24</td>
<td>9</td>
<td>8</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Luancheng county</td>
<td>17</td>
<td>9</td>
<td>5</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Pingshan county</td>
<td>8</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Lingshou county</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Wuji county</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Yuanshi county</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Luquan county</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Jinzhou county</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Yuhua district</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>66</td>
<td>33</td>
<td>21</td>
<td>15</td>
<td>33</td>
</tr>
</tbody>
</table>

* A patient with symptoms of botulism and a serum and/or stool sample positive for *C. botulinum* by use of toxin test or culture.

b A patient with symptoms of botulism and a serum sample negative for *C. botulinum* by use of toxin test who had consumed the same food as patients with a serum and/or stool sample positive for *C. botulinum* by use of toxin test or culture (ie, confirmed cases).

Results. All 66 case patients with signs and symptoms of botulism were investigated regarding illness onset and the consumption of sausage during the 10 days before illness onset. The mean incubation period was 65.8 h (range, 9–212.5 h). Interviews revealed that 28 case patients (42.4%) were men and 38 (57.6%) were women and that the median age was 33.5 years (range, 2–79 years). The patients were from 9 different counties in Hebei province, China, and all were from the countryside. Twenty-four patients were from Zhengding county, 17 from Luancheng county, 8 from Pingshan county, 5 from Lingshou county, 4 from Wuji county, 4 from Yuanshi county, 2 from Luquan county, 1 from Jinzhou county, and 1 from Yuhua district (Table 1). These areas are adjacent to each other. After collecting data on the recent eating habits of each case patient, we determined that the sausages manufactured by Qianfeng in Hebei province were the likely cause of this outbreak of food poisoning.

All 66 case patients were hospitalized and treated with 150,000 units of botulism antitoxin A (half by intramuscular injection and half by intravenous drip) and, at the same time, were afforded support therapy such as cathartics, enemas with 5% sodium bicarbonate, and oxygen. The median duration of treatment was 7 days (range, 5–14 days). Eight patients had severe cases; however, no mechanical ventilatory support was required, and no deaths occurred. The patients presented with varying degrees of gastrointestinal, respiratory, and neurological symptoms, including blurred vision (68.2% of patients), ptosis (66.7%), dizziness (63.6%), dysphagia (62.1%), fa-
tigue (45.5%), diplopia (40.9%), a hard tongue (30.3%), slurred speech (28.8%), nausea (19.7%), dysphonia (19.7%), headache (15.2%), hoarseness (13.6%), neck softness (12.1%), vomiting (6.1%), and difficulty raising the head (3.0%).

On the basis of descriptive results, a case-control study was conducted, and all suspected brands of sausage were investigated. An analysis of the results indicated that sausage was associated with the highest OR of 9.58 (95% CI, 3.40–28.36), whereas other foods did not appear to be associated with this outbreak of food poisoning (Table 2).

Sixty-six serum samples, 66 stool samples, and 10 suspected food samples were collected and sent to the diagnostic laboratory for analysis. Of the 66 serum samples, 33 (50%) tested positive for botulinum toxin type A by use of immunocolloidal gold kits. Of other 33 serum samples, 32 tested negative, and 1 had an inadequate amount of serum. The botulinum toxin type A was also detected in 21 stool samples obtained from 33 patients whose serum samples tested positive and in 5 of 10 remnant sausage samples. Fifteen C. botulinum strains from 21 stool samples and 2 strains from 5 food samples were isolated by culture and then verified as type A by use of an enzyme-linked immunosorbent assay. The sausages were produced by the Qianfeng Company in Hebei province and were sold in the local markets. These sausages were not marked with a production date or shelf life and were usually stored at room temperature.

Discussion. Foodborne botulism has mainly occurred in the northwest areas of China, especially in the northwest areas of the Yangtze River and the Xinjiang Uygur Autonomous Region [7, 8]. Such a large multilocus outbreak has rarely been reported in northern China, and the outbreak discussed here was the first report of C. botulinum linked with packaged food in China.

In this outbreak, we actively screened and investigated cases, and erected temporary surveillance for accepting suspected cases, that were reported until the end of the epidemiological investigation, with the help of the local health department, the Centers for Disease Control and Prevention, and the county hospital. After the investigation, the local health department and Centers for Disease Control and Prevention strengthened surveillance for botulism in patients with similar symptoms in rural areas and in the whole province until there were no new patients reported.

No deaths occurred in this outbreak, and the incubation period was longer than that of past outbreaks [9, 10]. This may be related to the fact that less contaminated sausage was eaten by the patients in this outbreak, compared with other outbreaks. After symptom onset, ocular, throat, and respiratory muscle paralysis occurred, but all symptoms were mild; also, gastrointestinal symptoms were fewer, compared with past reports [10–12].

After the epidemiological investigation and the analysis, it was found that all the patients had eaten the sausage produced by Qianfeng in Hebei province and that this sausage was seen as the cause of the food poisoning (OR, 9.58; 95% CI, 3.40–28.36). Subsequently, toxin type A was identified in the sausage samples obtained from the 66 patients’ homes, and the toxin was reported to be found in 5 of 10 remnant sausage samples. These results indicated that the sausage contaminated with botulinum toxin type A was a contributor to this large outbreak. The outbreak was attributed to the sausage being transported and stored in retail outlets without refrigeration. After interviewing patients, retailers, and manufacturers, we found that all the sausages sold in the local shops were transported and stored at room temperature, which may have provided the conditions suitable for spore germination and toxin production [9], and most of them had no marked production date or shelf life. In addition, spoilage (eg, softness and unpleasant odor) had occurred for some of the sausage.

All cases of botulism in this outbreak occurred in rural areas, and rural areas have become the main sales areas of substandard and/or expired foods. This large outbreak of botulism reminded us once again that the supervision of food safety in rural areas should be strengthened to prevent similar outbreaks of food poisoning, and a detailed food history of patients and an examination of potentially contaminated foods are important aspects of investigations of a suspected botulism outbreak. Such surveillance for food poisoning and other foodborne diseases should be strengthened, and knowledge of food safety and other infectious diseases should be required not only of public healthcare workers but also of civilians in the counties of China in the future.

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