Botulism in Native Peoples - An Economic Study

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ABSTRACT

Type E botulism occurs regularly in scattered locations in the Canadian Arctic and northern coastal British Columbia from the consumption of improperly fermented fish and marine mammal products by native peoples, with an average of eight cases and 1.5 deaths each year. Local treatment at nursing stations is often followed by the evacuation of the patients to the main northern hospitals, e.g. Iqaluit and Inuvik with subsequent intensive care, if necessary, in Montreal, Winnipeg, Edmonton or Vancouver. Estimates of costs of six incidents in these northern regions showed that the evacuation of patients was the most expensive component (mean, 31.2%), followed by hospitalization (23.8%) and investigation of the illnesses (19.4%). The mean cost per incident was over $70,000, or $7,200 per case. If these figures are extrapolated, the cost of botulism in these areas is about $2 million each year, with $1.5 million being considered the value of the lives lost. Current and future health care practices in northern regions should be evaluated in relation to these and other costs.

In Canada, botulism is a serious illness that affects mainly Inuit and Indian populations. This situation has been recognized for at least 50 years and although the mortality rate has dropped from over 50% before 1965 to about 18% in subsequent years the number of cases has not diminished. (4,5)

There are three main regions where botulism occurs with regularity: (a) the eastern arctic (mainly southern Baffin Island, northern Quebec and Labrador), (b) the western arctic (the Mackenzie estuary communities, such as Inuvik and Tuktoyaktuk), and (c) northern coastal British Columbia, including the Queen Charlotte Islands. The disease has also been reported from other widely scattered northern arctic communities, e.g., Coppermine, Cambridge Bay and Baker Lake (4). The source of the botulinal toxin is traditional native foods. Most incidents in the eastern and northern arctic have involved marine mammals (seal, walrus and whale) and to a lesser extent caribou and arctic char, whereas in the western arctic it has been exclusively muktuk (fermented whale blubber with skin and meat) and in British Columbia salmon eggs fermented by Indians (Table 1). These foods are prepared and stored today by native people in the same general way as by their Inuit and Indian ancestors, but there is enough variation in practice, such as their storage indoors as well as outside, and allowing the fermentation to take place in the open air as opposed to burying the food in the ground, and also weather conditions that may allow contaminating Clostridium botulinum spores to germinate and cells to grow. Such foods are often served at communal or family celebrations. Usually persons who later suffer from symptoms of botulism did not notice any spoilage problems at the time of consumption, even though there may be a distinct odor of putrefaction, noticeable to the health official picking up the sample and to laboratory analysts. Therefore, ill persons often do not present themselves to the nursing stations until symptoms have become acute. This frequently results in emergency treatment at the local clinic without staff having any knowledge that these traditional foods have been eaten, and early misdiagnoses may be made. Some native people will deliberately not mention such foods because they suspect health authorities frown upon their use. Once botulism is suspected, antitoxin is normally administered and the condition monitored. If the patients deteriorate further, they are flown to the larger hospitals in the north, e.g. at Iqaluit (Frobisher Bay) and Inuvik. If continued intensive care is required they are flown ("medivaced") to hospitals in Montreal (for eastern arctic patients), Edmonton or Winnipeg (for western and northern arctic patients) and Vancouver (for British Columbia patients).

The decrease in mortality rate in recent years is because better life-support systems are available, particularly use of antitoxin in remote nursing stations and improved air evacuation procedures (4). Nevertheless, these medical facilities are expensive, and it is the purpose of this study to examine the costs of episodes of botulism, from eastern and western arctic and also British Columbia, and extrapolate these to estimate the costs of botulism in northern Inuit and Indian communities. Costs are calculated in 1986 dollar values unless otherwise stated.

Botulism at Lake Harbour, Northwest Territories, 1985

Eleven adults and one child from five different Inuit families in Lake Harbour ate "fermented" walrus meat on the evening of July 30, 1985. Other foods, including raw
and cooked caribou, fish, raw and dried seal meat, eggs and beef, were also consumed. Twenty-four hours later a 29-year-old female who had eaten a large quantity of the walrus meat presented herself at the nursing station with complaints of nausea, vomiting, blurred vision and dry-mouth. Her blood pressure was 110/70, pulse 110 and respiration 20. Botulism was suspected and she was given antitoxin. Because the symptoms increased in intensity, she was flown from Lake Harbour to Frobisher Bay. She became progressively weaker at the hospital and was flown to Montreal with two nursing attendants. At the Montreal hospital she continued to be nauseous and have a dry mouth and showed ptosis and double vision. She did not require intensive care and gradually improved to be discharged after 8 d. In retrospect, the medivac to Montreal was probably not necessary, but there were concerns with the antitoxin use in Frobisher Bay. Instructions were limited as to what the dosage should be, and there was a possibility of an anaphylactic reaction from the horse serum.

Once botulism had been suspected in the patient, the 10 others who had consumed the food were flown to Frobisher Bay for observation. Some complained of stomach upsets and all were given antitoxin. They were boarded out in town overnight and examined again the next day. Because any possible symptoms had disappeared, no further treatment was given and they were flown back to Lake Harbour.

The walrus meat eaten had been stored in a skin pouch, but none was left for analysis. However, a second pouch of "fermented" meat from the same walrus was retrieved from the garbage. C. botulinum type E cells were isolated from the meat and walrus skin, but no toxin was found in these samples or in the patients’ serum or gastric aspirate. In mid-July the walrus was killed and gutted before being taken to Lake Harbour. The next day pieces of walrus meat, fat and bone were put into two skin pouches, tied shut and hung in the air for two weeks. Each pouch weighed about 23 kg. The pouches hung in the direct sunlight in day temperatures of 10-18°C. The person who prepared it recognized that the meat had not fermented properly and he indicated that it had been "suntanned." The traditional way is to bury the pouches up to three feet underground.

Only one case was diagnosed as having botulism, although some of the others eating the walrus may have consumed small amounts of toxin. This would indicate that the Clostridium botulinum type E growth and toxin production was localized within the pouch.

### Cost of the Lake Harbour incident

<table>
<thead>
<tr>
<th>Item Description</th>
<th>1985 Costs</th>
<th>1986 Costs</th>
<th>Percentage increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Loss to food preparer for two pouches of walrus meat (estimate)</td>
<td>$30</td>
<td>$31</td>
<td>(0.1%)</td>
</tr>
<tr>
<td>2. Hospitalization: a) bed care at</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i) Lake Harbour (1 d)</td>
<td>$300</td>
<td>$312</td>
<td>(1.5%)</td>
</tr>
<tr>
<td>ii) Frobisher Bay (1 d)</td>
<td>$350</td>
<td>$365</td>
<td>(1.8%)</td>
</tr>
<tr>
<td>iii) Montreal 8 d at $350/d</td>
<td>$2,800</td>
<td>$2,915</td>
<td>(14.1%)</td>
</tr>
<tr>
<td>b) hospital tests (estimate)</td>
<td>$200</td>
<td>$208</td>
<td>(1.0%)</td>
</tr>
<tr>
<td></td>
<td>$3,650</td>
<td>$3,800</td>
<td>(18.4%)</td>
</tr>
<tr>
<td>3. Fees for a) physicians at</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i) Frobisher Bay</td>
<td>$800</td>
<td>$833</td>
<td>(4.0%)</td>
</tr>
<tr>
<td>ii) Montreal (estimate)</td>
<td>$1,000</td>
<td>$1,041</td>
<td>(5.1%)</td>
</tr>
<tr>
<td>b) nurses at</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i) Lake Harbour</td>
<td>$125</td>
<td>$130</td>
<td>(0.6%)</td>
</tr>
<tr>
<td>ii) Frobisher Bay and on flight to Montreal</td>
<td>$240</td>
<td>$250</td>
<td>(1.2%)</td>
</tr>
<tr>
<td></td>
<td>$2,165</td>
<td>$2,254</td>
<td>(10.9%)</td>
</tr>
<tr>
<td>4. Medication a) antitoxin, 6 vials x $334/vial</td>
<td>$2,004</td>
<td>$2,086</td>
<td>(10.1%)</td>
</tr>
<tr>
<td>b) other medical supplies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i) Frobisher Bay</td>
<td>$156</td>
<td>$163</td>
<td>(0.8%)</td>
</tr>
<tr>
<td>ii) Montreal (estimate)</td>
<td>$200</td>
<td>$208</td>
<td>(1.0%)</td>
</tr>
<tr>
<td></td>
<td>$2,360</td>
<td>$2,457</td>
<td>(11.9%)</td>
</tr>
<tr>
<td>5. Investigation a) epidemiology:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i) community health worker visiting community</td>
<td>$300</td>
<td>$312</td>
<td>(1.5%)</td>
</tr>
<tr>
<td>ii) environmental health officer interviewing and publicizing the event</td>
<td>$450</td>
<td>$469</td>
<td>(2.3%)</td>
</tr>
<tr>
<td>b) transport of specimens to laboratories</td>
<td>$100</td>
<td>$104</td>
<td>(0.5%)</td>
</tr>
<tr>
<td>c) administration costs</td>
<td>$100</td>
<td>$104</td>
<td>(0.5%)</td>
</tr>
</tbody>
</table>

### Table 1. Cases and deaths associated with botulism in Canada, 1971-1985, by ethnic group and foods eaten (4,5).

<table>
<thead>
<tr>
<th>Ethnic group</th>
<th>Foods causing botulism</th>
<th>No. of incidents</th>
<th>No. of cases</th>
<th>No. of deaths</th>
<th>Fatality: case ratio (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inuit eastern arctic</td>
<td>seal, walrus, whale, caribou, char</td>
<td>41</td>
<td>89</td>
<td>15</td>
<td>16.9</td>
</tr>
<tr>
<td>western arctic</td>
<td>muktuk</td>
<td>4</td>
<td>6</td>
<td>1</td>
<td>16.7</td>
</tr>
<tr>
<td>northern arctic</td>
<td>seal, caribou, fish</td>
<td>5</td>
<td>7</td>
<td>2</td>
<td>28.6</td>
</tr>
<tr>
<td>Indian northwest coast</td>
<td>fermented salmon eggs</td>
<td>8</td>
<td>17</td>
<td>4</td>
<td>23.5</td>
</tr>
<tr>
<td>Total native peoples</td>
<td></td>
<td>58</td>
<td>119</td>
<td>22</td>
<td>18.5</td>
</tr>
<tr>
<td>Non-native population</td>
<td></td>
<td>9</td>
<td>46</td>
<td>1</td>
<td>2.2</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>67</td>
<td>165</td>
<td>23</td>
<td>13.9</td>
</tr>
</tbody>
</table>
d) laboratory analysis
   i) Frobisher Bay hospital $300 $312 (1.5%)
   ii) Montreal hospital (estimate) $250 $260 (1.3%)
   iii) Ottawa Health Protection Branch $1,300 $1,354 (6.5%)

   subtotal $2,800 $2,915 (14.1%)

6. Evacuation of patient and suspect cases from Lake Harbour to hospitals
   a) patient from Lake Harbour to Frobisher Bay $900 $937 (4.5%)
   b) patient from Frobisher Bay to Montreal (includes
       2 escort fares, stretcher patient airfare, ambulance
       services and escort accommodations) $3,530 $3,675 (17.8%)
   c) patient from Montreal to Lake Harbour via Frobisher
       Bay on recovery (includes overnight accommodation) $600 $625 (3.0%)
   d) 10 suspect cases medivaced from Lake Harbour to
       Frobisher Bay, two nights accommodation and return
       by scheduled flight $2,200 $2,290 (11.1%)

   subtotal $7,230 $7,527 (36.4%)

7. Income lost through
   a) illness of patient, 13 d x $90/d $1,170 $1,218 (5.9%)
   b) observation of 10 suspect cases, 4.5 d x $100/d $450 $468 (2.3%)

   subtotal $1,620 $1,686 (8.2%)

8. Total costs for 1 case
   $19,855 $20,670 (100.0%)

*Information from H. K. Toma, Director of Patient Services, Baffin Regional Hospital, Frobisher Bay and B. Kelso, Environmental Health Officer, Medical Services Branch Health and Welfare Canada, Frobisher Bay, Northwest Territories. Note: The name Frobisher Bay was changed to Iqualuit on January 1, 1987.

Botulism in the Mackenzie River Delta, Northwest Territories, 1984-86*

Four separate incidents of botulism occurred in the Mackenzie River delta area, specifically in or near Tuktoyaktuk and Inuvik, between 1984 and 1986. In the first three of these, *C. botulinum* type E was confirmed as the cause; in the fourth incident it was assumed, but not proven, that type E organisms were responsible. All involved the consumption of muktuk, and they have been combined for cost analysis.

**Incident No. 1.** In the fall of 1984 a large quantity of muktuk was prepared at a whaling station near Tuktoyaktuk. Whale blubber had been placed in 5-gallon pails and buried in the ground for 2 weeks. It was then shipped to Inuvik and stored in five household freezers. On October 16 five persons consumed some of this for lunch. Two women developed symptoms of botulism and were flown to Edmonton after receiving antitoxin. The older patient (70-years old) died the next day but the younger one recovered after a few days. The incriminated muktuk, found to contain botulinal toxin, was destroyed by the Medical Services Branch.

**Incident No. 2.** On December 4 of the same year two persons ate muktuk at an evening meal at a camp 40 km west of Inuvik. The 40-year-old male who ate the larger quantity had symptoms of nausea, vomiting and blurred vision the next morning. He was put on a sleigh and towed by snowmobile for 3 h before arriving at the Inuvik hospital. By this time he was comatose and had a temperature of 32.6°C. He was warmed up, given antitoxin and flown with a medical team to Edmonton by chartered jet. After being hospitalized for over 11 days he eventually recovered.

**Incident No. 3.** On the evening of July 25, 1985, 11 persons ate muktuk at several homes in Tuktoyaktuk. Two days later one of them was admitted to the nursing station with apparent weakness and double vision. After he was examined, he was flown to Inuvik where he was given antitoxin. Some muktuk from one of the homes was still available but did not contain *C. botulinum* cells or toxin. However, toxin was found in the patient’s feces and serum.

**Incident No. 4.** On August 7, 1986, 25 persons ate dry and boiled caribou, raw and cooked muktuk and canned strawberries at a whaling camp on East Whitefish Channel, some 50 km south of Tuktoyaktuk. On August 9, three of these exhibited nausea, vomiting, abdominal pain and malaise, and medical staff decided to evacuate them to Inuvik where they were hospitalized. One was released after examination, but the two others were held overnight and the following day antitoxin was given after a tentative diagnosis of botulism had been made. Although the disease was suspected, no evidence of *C. botulinum* cells or toxin was found in clinical specimens or samples of muktuk examined.

*Information supplied by William Murray, Environmental Health Officer, Inuvik Zone, Medical Services Branch.

Botulism in the Queen Charlotte Islands, British Columbia 1985(3)

At a noon meal in December, a 74-year-old Haida man of Masset, Queen Charlotte Islands, his 72-year-old wife, his mother and sister ate fermented salmon eggs. Nearly 2 d later the wife became ill and was seen by a physician at her home. Because of her severe respiratory distress she was admitted to the hospital. She was given intravenous fluids, but after some initial improvements was found to have expired in her bed a few hours later. Her husband, who had...
b) outpatient  
   i) hospital tests, e.g., electrocardiogram  
   ii) technician overtime  
   subtotal

3. Fees for  
   a) physicians  
   b) nurses  
   c) neurologist  
   d) pharmacist  
   subtotal

4. Medication  
   a) antitoxin  
   b) other, e.g., antibiotics, intravenous solutions  
   subtotal

5. Investigation  
   a) epidemiology  
      i) environmental health officers  
      ii) police  
      iii) telephone  
      iv) travel for investigating team  
      v) report writing  
   b) laboratory analysis  
      i) provincial laboratory  
      ii) federal laboratory  
      iii) transportation of specimens to Edmonton and Ottawa  
   subtotal

6. Flights for patients and medical staff to hospitals  

7. Loss of income (estimate)  

8. Total costs excluding death  

9. Average cost per case excluding death  

10. Value of death (70-yr-old female)  

11. Total costs including death  

12. Average cost per case  

<table>
<thead>
<tr>
<th>Incident No. 1 (2 cases)</th>
<th>Incident No. 2 (1 case)</th>
<th>Incident No. 3 (1 case)</th>
<th>Incident No. 4 (2 cases)</th>
<th>Total costs for 4 incidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss to Muktuk supplier (estimate)</td>
<td>$217</td>
<td>$217</td>
<td>(0.1%)</td>
<td></td>
</tr>
</tbody>
</table>
| Hospitalization  
   a) bed care at  
      i) Inuvik  
      ii) Edmonton  
   b) outpatient  
      $16 | $17 | $33 | (0.0%) |
   c)  
      i) hospital tests, e.g., electrocardiogram  
      ii) technician overtime  
      subtotal  
         $1,583 | $7,176 | $1,853 | $840 | $11,452 | (6.4%) |
| Fees for  
   a) physicians  
   b) nurses  
   c) neurologist  
   d) pharmacist  
   subtotal  
   $1,095 | $2,235 | $1,408 | $656 | $5,394 | (3.0%) |
| Medication  
   a) antitoxin  
   b) other, e.g., antibiotics, intravenous solutions  
   subtotal  
   $426 | $428 | $902 | $837 | $2,593 | (1.5%) |
| Investigation  
   a) epidemiology  
      i) environmental health officers  
      ii) police  
      iii) telephone  
      iv) travel for investigating team  
      v) report writing  
   b) laboratory analysis  
      i) provincial laboratory  
      ii) federal laboratory  
      iii) transportation of specimens to Edmonton and Ottawa  
   subtotal  
   $1,668 | $1,099 | $2,424 | $1,376 | $6,567 | (3.7%) |
| Flights for patients and medical staff to hospitals  
   $3,084 | $9,530 | $568 | $661 | $13,843 | (7.8%) |
| Loss of income (estimate)  
   $270 | $1,679 | $1,041 | $270 | $3,260 | (1.8%) |
| Total costs excluding death  
   $8,343 | $22,147 | $8,196 | $4,640 | $43,326 | (24.3%) |
| Average cost per case excluding death  
   $2,217 | $217 | $471 | $220 | $1,125 | (0.6%) |
| Value of death (70-yr-old female)  
   $135,122 | NA* | NA | NA | $135,122 | (75.7%) |
| Total costs including death  
   $143,465 | NA | NA | NA | $178,451 | (100.0%) |
| Average cost per case  
   $71,733 | $22,147 | $8,196 | $4,640 | $29,742 |

*NA = not applicable.

Information supplied by William Murray, Environmental Health Officer, Inuvik Zone, Medical Services Branch.

been seen by the physician and had complained of slight shortness of breath and malaise at that time, was brought to the hospital by ambulance the evening his wife died. He was unconscious and could not be resuscitated. The mother and sister did not become ill. It was only at this stage that knowledge of the salmon egg consumption was given to health authorities. Autopsies of the bodies were conducted in Vancouver, and the Botulism Reference Centre found C. botulinum type E toxin in the stomach contents and stools of both victims, in the serum of the woman, and in the salmon eggs. The eggs had been stored in a crock pot and washed with rain water every 2 or 3 d for a month, then covered and put in a cool place.

Comparison of costs of the incidents in the three locations

The types of costs of the incidents were in general, very similar, with evacuation of patients to hospitals, hospitalization and the investigations being the most expensive items (Table 2). The medivac procedure was the most costly for
1. Loss to food preparer

2. Hospitalization:
   a. 1.5 day intensive care x $1,000/d
   b. ambulance

3. Physician's fee for: 2 house calls and hospital visits

4. Medication (estimate)

5. Investigation:
   a. epidemiology:
      i) public health inspector (total 2 d)
      ii) epidemiologist and physician (total 3 d)
      iii) community health workers (total 4 d)
      iv) police (total 2 d)
      v) travel for investigative team
   b. autopsy: 2 pathologists
   c. laboratory analysis:
      i) provincial laboratory
      ii) federal laboratory 5 d x $150
      iii) transport of specimens to Vancouver and Ottawa

6. Flight for deceased to Vancouver for autopsy and return for burial

7. Loss of income

8. Total costs for 2 cases excluding death

9. Average cost per case (excluding death)

10. Value of 2 deaths:
    74-yr-old man
    72-yr-old woman

11. Total costs for 2 cases including death

12. Average cost per case (total costs)

Information supplemented by D. Bowering, Field Epidemiologist, Laboratory Centre for Disease Control, Victoria, British Columbia.

### TABLE 2. Comparison of costs, excluding the value of deaths, of the incidents in three geographic locations.

<table>
<thead>
<tr>
<th>Item costed</th>
<th>Lake Harbour</th>
<th>Mackenzie delta</th>
<th>Queen Charlotte Is.</th>
<th>Mean of all incidents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1985 costs $</td>
<td>1986 costs $</td>
<td>1985 costs $</td>
<td>1986 costs $</td>
</tr>
<tr>
<td>Evacuation of patients</td>
<td>7,527</td>
<td>3.4%</td>
<td>1</td>
<td>13,843</td>
</tr>
<tr>
<td>Hospitalization</td>
<td>3,800</td>
<td>18.4%</td>
<td>2</td>
<td>11,452</td>
</tr>
<tr>
<td>Medical fees</td>
<td>2,254</td>
<td>10.9%</td>
<td>5</td>
<td>5,394</td>
</tr>
<tr>
<td>Investigation</td>
<td>2,915</td>
<td>14.1%</td>
<td>3</td>
<td>6,567</td>
</tr>
<tr>
<td>Medication</td>
<td>2,457</td>
<td>11.9%</td>
<td>4</td>
<td>2,593</td>
</tr>
<tr>
<td>Income lost through illness</td>
<td>1,686</td>
<td>8.2%</td>
<td>6</td>
<td>3,260</td>
</tr>
<tr>
<td>Value of food discarded</td>
<td>31</td>
<td>0.1%</td>
<td>7</td>
<td>217</td>
</tr>
<tr>
<td>Total</td>
<td>20,670</td>
<td>100.0%</td>
<td>43,326</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

The Lake Harbour and Inuvik patients. Charter flights were required to airlift patients, suspect cases and nursing staff, but regular scheduled flights were also expensive because travel in the north is more costly and each passenger (patients and nurses) had return tickets. In the Queen Charlotte Islands' incident the patients died before any travel was considered, and costs were minimal (travel of the bodies for autopsy). Because botulism is a neurological disease, recovery is slow and often requires intensive care for several days to weeks, and the amount of time spent in a hospital by these northern patients cost several thousand dollars. A considerable amount of technical support is also necessary to treat a potential botulism case, both at the clinics and at the hospitals. In the Lake Harbour incident, technicians had to work at night which required overtime pay. Medication was not expensive, except for the antitoxin which cost over $300/vial. Nurses, environmental health officers of the Medical Services Branch, community health workers, Royal Cana-
TABLE 3. Summary of costs of incidents of botulism in three geographic locations.

<table>
<thead>
<tr>
<th>Incidents</th>
<th>No. of Cases</th>
<th>Costs (deaths included)</th>
<th>Costs (deaths excluded)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total ($)</td>
<td>Per case ($)</td>
</tr>
<tr>
<td>Lake Harbour, 1985</td>
<td>6</td>
<td>178,451</td>
<td>29,742</td>
</tr>
<tr>
<td>Mackenzie delta, 1984-86</td>
<td>6</td>
<td>178,451</td>
<td>29,742</td>
</tr>
<tr>
<td>Queen Charlotte Is., 1985</td>
<td>2</td>
<td>191,515</td>
<td>95,758</td>
</tr>
<tr>
<td>Total</td>
<td>9</td>
<td>390,636</td>
<td>29,742 median</td>
</tr>
</tbody>
</table>

TABLE 4. Value of cases who died from botulism.*

<table>
<thead>
<tr>
<th>Age and sex of deceased</th>
<th>Value allotted (1986$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>74 yr-old male</td>
<td>49,314</td>
</tr>
<tr>
<td>70 yr-old female</td>
<td>135,122</td>
</tr>
<tr>
<td>72 yr-old female</td>
<td>135,122</td>
</tr>
<tr>
<td>Total</td>
<td>135,122 median</td>
</tr>
<tr>
<td></td>
<td>106,519 mean</td>
</tr>
<tr>
<td>Suggested value Inuit</td>
<td>100,000</td>
</tr>
<tr>
<td>and Indian cases who</td>
<td></td>
</tr>
<tr>
<td>died</td>
<td></td>
</tr>
</tbody>
</table>
*Based on willingness-to-pay and human capital estimates of Landfield and Seskin (8).

Value of cases who died from botulism

Estimate of costs of botulism in native peoples

From 1971 to 1985 119 Inuit and Indian cases of botulism were recorded with 22 deaths. This averages out to 8 cases and 1.5 deaths each year. However, it is probable that many cases of botulism go unrecognized and deaths may be assigned to different causes. For instance, in one of the two botulism cases that occurred in the Queen Charlotte Islands, the cause of the dyspnea was considered to be congestive heart failure, pleural effusion or pneumonia, before knowledge of the consumption of the fermented salmon eggs was obtained and botulism confirmed. Therefore, an estimate of the number of cases and deaths should be multiplied by a factor of at least 10.

Therefore, costs of cases = 8 (average no. of cases each year) x 10 (multiplication factor for undiagnosed cases) x $7,200 (rounded off median cost per case, death excluded, Table 3) = $576,000.

cost of deaths = 1.5 (average no. of deaths each year) x 10 (multiplication factor for improperly diagnosed deaths) x $100,000 = $1,500,000.

Total annual costs for cases and deaths = $2,076,000.

Conclusions

Botulism outbreaks have been recorded sporadically in various European countries, U.S.S.R., Iran, China, Japan and Argentina, as well as North America (A.H.W. Hauschild, Botulism Reference Centre, Health Protection Branch, Ottawa, personal communication), but those involving United States products have been the most widely
TABLE 5. Costs of botulism associated with United States products.  

<table>
<thead>
<tr>
<th>Year</th>
<th>Implicated food</th>
<th>Where eaten</th>
<th>No. of cases</th>
<th>Total costs ($)</th>
<th>Cost/case($)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977</td>
<td>jalapeno peppers</td>
<td>U.S. restaurant</td>
<td>59</td>
<td>1,485,060</td>
<td>25,170</td>
<td>16</td>
</tr>
<tr>
<td>1963</td>
<td>canned tuna</td>
<td>U.S. home</td>
<td>3</td>
<td>167,306,600</td>
<td>55,768,900</td>
<td>15</td>
</tr>
<tr>
<td>1978</td>
<td>canned bean salad+</td>
<td>U.S. club</td>
<td>34</td>
<td>8,526,800</td>
<td>250,788</td>
<td>15</td>
</tr>
<tr>
<td>1978</td>
<td>canned salmon</td>
<td>U.K. home</td>
<td>4</td>
<td>6,277,650</td>
<td>1,569,413</td>
<td>15</td>
</tr>
<tr>
<td>1982</td>
<td>canned salmon</td>
<td>Belgium home</td>
<td>2</td>
<td>150,181,900</td>
<td>75,090,950</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>102</td>
<td>333,778,010</td>
<td>327,233</td>
<td></td>
</tr>
</tbody>
</table>

*All costs updated to 1986 U.S. dollars (includes value of lives lost) +or potato salad served at the club.

publicized. These last include home-prepared items, e.g. bottled mushrooms (6), marinated kingfish (12), restaurant foods, e.g. potato salad (13), jalapeno peppers (14) and sauteed onions (9), and commercial products, e.g. canned tuna (7), canned hot peppers (2), bottled mushrooms (17) and canned salmon (1,15), and costs of five of these have been attempted (15,16) (Table 5). With mean costs per case (value of deaths included) of over $327,000, these types of botulism outbreaks are much more expensive than those associated with native peoples. The main reasons for these high costs are loss of business and legal settlements which do not apply to any great extent in the home-associated northern incidents. This may change in the future. Native products, such as muktuk, are available locally in retail stores (sold frozen), but there is a desire to produce these on a larger scale for more widespread distribution. If illnesses are proven to be associated with a commercial fermented product, then legal action may occur.

Therefore, although botulism in the north and west of Canada is not typical of the larger restaurant and canned food outbreaks of the United States (and the 1985 episode from garlic in oil served in a Vancouver restaurant that has yet to be costed), the impact is still great and shows no signs of diminishing. As the government in Northwest Territories becomes more independent of federal control (currently Medical Services Branch staff are being replaced by Northwest Territories staff), it is important that medical vigilance not be relaxed nor the facilities cut back. Because native peoples are not giving up eating their traditional foods, and, in fact, are encouraging more distribution of these products, incidents of botulism are going to continue. Active immunization with toxoid and educational programs on proper preparation and storage of native foods as recommended by Hauschild and Gauvreau (4), are means of controlling the problem. Benefit-cost studies of these preventive measures should be done to compare these with the high costs of treating botulism victims and grief over unnecessary deaths.

ACKNOWLEDGMENT

This economic analysis could not have been done without the goodwill and sincere cooperation of the medical services staff in the Northwest Territories.