Sources of Shellfish in Outbreaks of Probable Viral Gastroenteritis: Implications for Control

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ABSTRACT

Shellfish have been identified as vehicles of foodborne enteric disease in the United States since the first part of the twentieth century, when numerous outbreaks of shellfish-associated typhoid fever were reported. In 1925, the U.S. Public Health Service sponsored a conference that developed the first national guidelines governing the sanitary control of the shellfish industry known as the National Shellfish Sanitation Program (NSSP) (4). Surveillance for reported shellfishborne outbreaks/incidents and cases in the United States has been maintained since 1925; the reported outbreaks since 1900 are summarized in Table 1 (27).

Until recently, shellfish-associated illness was reported sporadically and infrequently within New York State. Current increased activity began with an outbreak of gastroenteritis associated with raw hard-shell clams, which occurred over a period of several days in June 1981. This outbreak was traced to a foodservice establishment specializing in clambakes. Approximately 5,973 people ate at the establishment during the period. Of these, 537 were interviewed; 234 (44%) of them had become ill. Major symptoms included: diarrhea, 81%; vomiting, 47%; abdominal cramps, 51%; and fever, 26%. The mean incubation period was 41 h and the mean duration of the illness was 44 h. No bacterial agent could be confirmed. Raw hard-shell clams were epidemiologically incriminated as the vehicle.

From May through December 1982, hundreds of incidents of shellfish-associated illness, affecting thousands of people, were observed throughout New York State (16). These incidents included 103 well-documented outbreaks in which 1,017 persons became ill: 813 cases were clam-related and 204 were oyster-related. The most common symptoms were diarrhea, nausea, abdominal cramps and vomiting. Incubation periods were generally 24 to 48 h, with a duration of 24 to 48 h. Ten cases of hepatitis A were identified in persons from five of the early outbreaks, leading to subsequent recommendations for prophylactic use of immunoglobulin. Norwalk agent was confirmed as the etiologic agent in five of the seven outbreaks in which serologic testing was performed.

During 1983, 37 shellfish outbreaks, involving 595 cases of gastroenteritis, were reported. In 1984, there

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2Bureau of Communicable Disease Control.
TABLE 1. Reported shellfish disease outbreaks in the United States from 1900 to 1983 (21).

<table>
<thead>
<tr>
<th>Etiology</th>
<th>No. of outbreaks/ No. of incidents</th>
<th>No. of cases</th>
<th>Range of years reported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typhoid fever</td>
<td>94</td>
<td>3,268</td>
<td>1900-1954</td>
</tr>
<tr>
<td>Gastroenteritis, diarrhea, food poisoning</td>
<td>65</td>
<td>4,023</td>
<td>1934-1983</td>
</tr>
<tr>
<td><em>Vibrio parahaemolyticus</em></td>
<td>4</td>
<td>51</td>
<td>1977-1980</td>
</tr>
<tr>
<td><em>Vibrio cholerae</em></td>
<td>6</td>
<td>18</td>
<td>1977-1983</td>
</tr>
<tr>
<td>Hepatitis A</td>
<td>28</td>
<td>1,293</td>
<td>1961-1981</td>
</tr>
<tr>
<td>Norwalk agent</td>
<td>1</td>
<td>6</td>
<td>1980</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>198</strong></td>
<td><strong>8,659</strong></td>
<td><strong>1900-1983</strong></td>
</tr>
</tbody>
</table>

dockside. The clams are bought by size and/or weight and/or count depending on the local custom. Shellfish shippers are required to keep records of from whom they buy clams, the date, quantity and the location where the clams were harvested. Shellfish shippers usually grade the shell stock purchased from many diggers according to size. This means that shellfish caught by several diggers have been commingled when sold by a shipper. Shippers are required to affix a tag to the shell stock containers they sell. The information contained on this tag is listed in Table 2.

Each shipper and reshipper is required to keep a record of this tag information. The tag remains with the shell stock throughout its journey to the retail market. Theoretically, this system allows for rapid identification of the source of the shellfish when an illness is associated with consumption.

Shellfish sold by shellfish shippers often pass through the hands of additional middlemen—referred to as reshippers—before arriving at the point of final sale. These reshippers often legally remove the tag that arrives on the bag of shellfish and replace that tag with their own. In this way, they prevent their customers from learning of the other supplier and denying them future business. Reshippers may also regrade the shell stock from more than one container, thereby further increasing the total number of original diggers whose catch might be commingled in a single container. Reshippers are also required to place information on their tags (Table 2).

**METHODS**

Investigations of the shellfish sources in these outbreaks involved joint efforts by many local health departments, the State Health Department, the State Department of Agriculture and Markets, the State Department of Environmental Conservation, similar state and local agencies in other source states, and the U.S. Food and Drug Administration. Investigators attempted to obtain original shellfish tags at the point of service if they were kept. Bills of sale and interviews with shellfish servers were also used. In many cases, shellfish from more than one source were served at a meal in question. This required a full investigation back to all of the implicated sources. Records were traced from one reshipper to another with each step often implicating one or more additional possi-
Table 3 summarizes the sources of shellfish implicated in the 1981 to 1985 shellfishborne outbreaks. The clams implicated in the 1981 outbreak were from England. Clams implicated in the 22 outbreaks during the summer of 1982 were traced to Rhode Island waters in 13 outbreaks and to Massachusetts waters in two outbreaks. In six of the outbreaks, several states and one Canadian province were identified as the possible harvesting source of the clams.

**TABLE 3. Sources and number of shellfish-associated outbreaks and cases of foodborne disease.**

<table>
<thead>
<tr>
<th>Year</th>
<th>New York Outbreaks</th>
<th>New York Cases</th>
<th>Rhode Island Outbreaks</th>
<th>Rhode Island Cases</th>
<th>Massachusetts Outbreaks</th>
<th>Massachusetts Cases</th>
<th>England Outbreaks</th>
<th>England Cases</th>
<th>North Carolina Outbreaks</th>
<th>North Carolina Cases</th>
<th>Prince Edward Island Outbreaks</th>
<th>Prince Edward Island Cases</th>
<th>Unknown Outbreaks</th>
<th>Unknown Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>234</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1982</td>
<td>69</td>
<td>490</td>
<td>31</td>
<td>625</td>
<td>3</td>
<td>32</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>78</td>
<td>6</td>
<td>34</td>
</tr>
<tr>
<td>1983</td>
<td>6</td>
<td>140</td>
<td>1</td>
<td>20</td>
<td>7</td>
<td>145</td>
<td>9</td>
<td>157</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>42</td>
</tr>
<tr>
<td>1984</td>
<td>8</td>
<td>217</td>
<td>3</td>
<td>22</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>17</td>
</tr>
<tr>
<td>1985</td>
<td>5</td>
<td>40</td>
<td>1</td>
<td>44</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>thru May</td>
<td>88</td>
<td>887</td>
<td>36</td>
<td>411</td>
<td>10</td>
<td>177</td>
<td>10</td>
<td>391</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>78</td>
<td>24</td>
<td>107</td>
</tr>
</tbody>
</table>

*More than one state was implicated in some outbreaks, therefore, some outbreaks are counted more than once.*

**PROBLEMS ASSOCIATED WITH SOURCE INVESTIGATIONS**

Great difficulty was experienced in determining the sources of clams for many outbreaks. A study of the problems encountered for the outbreaks during the summer of 1982 showed the following results. In only 6 out of 12 outbreaks in which a commercial establishment served the clams, were required shellfish tags kept. In five of these cases, the tags were incomplete. Verbal information as to source was all that was available in 4 of 12 outbreaks where retail establishments sold the shellfish. Shellfish-tag stubs were not retained by 5 of 22 shellfish reshippers. Shellfish reshippers listed the wrong source on their reshipper tags in 2 of 22 outbreaks. One reshipper involved was not licensed to operate by the State Department of Environmental Conservation.

In many cases, the tag was missing or torn. Tags are usually made of paper and storage of shell stock in damp coolers caused the paper to weaken. Repeated handling of the containers often lead to inadvertent damage or removal of the tag.

The source investigations were further complicated by the number of hands the shellfish passed through between the harvesting waters and the consumer. In no case were we able to identify specific diggers or precise source waters because shellfish tags only named shippers and/or reshippers, as required by the NSSP. Source waters were designed in broad terms (e.g., Narragansett Bay). In many cases, shellfish from more than one source were served at the same event. Reshippers often handled shellfish from more than one shipper and their records were not specific enough to allow exclusion of sources that were not involved.

**TYPICAL INVESTIGATION FINDINGS**

To demonstrate the type of investigations conducted, descriptions of two outbreaks follow. Figure 1 illustrates the kind of branching charts uncovered during a source investigation.
Shellfish-tagging regulations are intended to provide an easy method for identifying the source of shellfish in the event of an outbreak. Untold man-hours and dollars have been expended in these investigations often only to conclude that any one of several sources may have been to blame for a confirmed outbreak of shellfishborne gastroenteritis. In an effort to stem the tide of outbreaks, a policy was adopted by New York State in 1983 to place a statewide embargo on the original shipper whose shellfish were implicated in an outbreak. The time lag involved in developing the necessary evidence for such an action, if the evidence existed at all, has limited this approach to a total of five instances since then. It can be concluded from this experience that shellfish tags do not meet their intended purpose of providing a link to an outbreak, nor are they an effective tool for accountability that can result in enforcement action.

These shellfish outbreaks have occurred for a number of reasons. However, due to the inadequacy of the current shellfish-tagging requirements, as written and enforced, the exact waters where shellfish were harvested will never be known. Hence, we are left merely to speculate as to possible contributing factors. The most likely factors were as follows:

1. The underlying cause for the viral gastroenteritis outbreaks is pollution of estuaries with human sewage. Shellfish are not inherently bad. They are filter feeders that concentrate microscopic matter suspended in water. Unfortunately, this includes bacteria and viruses. Viruses can survive sewage treatment. The pollution problem is further magnified by the consumer’s desire to eat these animals alive, intestinal tract and all.

2. Shellfish may have been harvested from closed/polluted waters. Many shellfishermen disregard harvesting restrictions. Some diggers admit that when finances are tight they “go to the bank” (bootleg). Many people in the shellfish industry refuse to admit that these illness problems can occur as a result of illegitimate harvesting (5).

3. Some waters where shellfish are being legally harvested may be improperly classified. This, in turn, may be due to inadequate resources to properly evaluate harvest waters (3) and/or misapplication of the current classification criteria.

4. Storm water can wash sewage onto growing beds. Certain outbreaks occurred after periods of heavy rain in harvesting areas. Sewage from communities with no sewage treatment facilities, which discharge to estuaries or communities with combined sewers that dump untreated sewage past sewage treatment facilities into estuaries during storms, have been responsible for outbreaks in the past (13,17,18).

5. Conditional beds are opened too soon. Shellfish beds subject to significant contamination after rainfalls are closed for a period of time to allow the shellfish to self-cleanse. If the beds are opened too soon, the cleans-
ing process may not be complete. This is particularly true for viruses that are retained by shellfish much longer than bacteria (7,14).

6. There is inadequate enforcement of harvesting and tagging requirements. Regulatory agencies are often short-staffed due to budgetary problems (3). In some states, multiple agencies are involved in enforcing regulations. This may result in less coordinated efforts. When one of many diggers sells shellfish to a shipper, it is only the digger’s word that the shellfish came from safe waters. The shipper and reshippers may mix, sort and commingle the shellfish several times before they are consumed, thereby making it impossible to trace bad shellfish back to any one shipper, let alone any one digger. All that shippers or reshippers can do in the current system is provide a list of from whom they bought shellfish on a given day.

7. Judges do not levy strong penalties on violators. In many areas, diggers are looked upon as folk heroes. Their cases are often plea bargained to lesser charges and/or they receive a “slap on the wrist” (3).

8. The bacteriologic water quality standards are inadequate to assure viral safety in shellfish (19). Pathogenic viruses may be present in waters and/or shellfish that comply with the bacteriologic standards for harvesting (6,9,10,20). Researchers have been unable to show a correlation between the presence of enteric viruses and coliform, fecal coliform or aerobic plate count bacteria in shellfish or the waters in which they live (8,9,22). Enteric viruses have been recovered from waters and shellfish that meet the bacteriologic standard for harvesting. The infectious dose for enteric viruses is not known but is assumed to be a very small number of virus particles (12).

**POSSIBLE SOLUTIONS**

The following is a list of actions that might contribute to the solution of the problems of shellfishborne disease. The shellfish industry and shellfish sanitation regulators have long debated these approaches. It is time for some or all of these steps to be implemented.

1. Improve shellfishborne disease surveillance and reporting. As with other foodborne disease surveillance, the tip of the iceberg is all that may be reported in shellfishborne disease. Better reporting is needed to better define the problem, as well as to provide information needed to find solutions.

2. Embargo shellfish sold by shippers implicated in disease outbreaks. This approach has been used five times in 2 years by the New York State Health Department to remove contaminated shellfish from commerce.

3. Adopt strict state and federal laws or regulations to deter the illegal harvesting of shellfish. It is reasonable to assume that a significant percentage of the recent New York State outbreaks has been caused by poachers harvesting in closed, known-to-be polluted waters.

4. Accomplish greater participation in the Interstate Shellfish Sanitation Conference. This is an organization of state shellfish regulatory agencies, with participation of federal agencies and industry. The ISSC’s goal is to provide a uniform, effective national shellfish sanitation program through voluntary state cooperation. Provincial, state and industry interests will make it very difficult for this organization to implement significant changes in the system, as they are often unwilling to admit that they have a problem or compromise their interests for the greater good.

5. Provide an adequate number of enforcement officers properly equipped to control round-the-clock illegal harvesting.

6. Develop a microbiologic growing water and/or product standard that assures viral as well as bacteriologic safety of shellfish.

7. Properly classify harvesting waters, including conditional waters.

8. Mandate a manifest-type tagging system. Such a system would require each harvester to place a tamper-evident tag on each container of shellfish harvested. Such a tag would be sold by the regulatory agency and would bear a sequential serial number on record at the regulatory agency and traceable to the digger. This tag would remain on the container and would not be broken until it reached the consumer. Each shipper or reshipper would place his shipper number and date of shipment on the original tag. The State of Massachusetts adopted a similar regulation early in 1985 (1).

9. Strictly enforce retail and wholesale shellfish-tagging requirements. Levy stiff penalties against all violators.

10. Require depuration (microbiologic cleansing for 48 h in purified sea water) of all shellfish sold. Depuration as currently practiced cannot guarantee virus-free shellfish, however (11,14).

11. Advise the public against the consumption of raw or partially cooked shellfish. The New York State Health Department took this position in July 1982. The Second National Food Protection Conference made this recommendation in May 1984 (2).

**CONCLUSIONS**

Shellfish continue to be the vehicles of a significant number of foodborne disease cases in the United States. Traditional control programs, no matter how well intentioned, have not been effective in controlling the newly emerging disease agents. New approaches will have to be tried and succeed, no matter how unpopular, or else the consumption of raw shellfish will face a total ban in the future.

**ACKNOWLEDGMENTS**

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REFERENCES


