CHOLERA IN PORTUGAL, 1974
I. MODES OF TRANSMISSION

PAUL A. BLAKE, MARK L. ROSENBERG, JOSE BANDEIRA COSTA, PEDRO SOARES FERREIRA, CESAR LEVY GUIMARAES and EUGENE J. GANGAROSA


In April-November 1974, Portugal had a cholera epidemic caused by Vibrio cholerae El Tor Inaba with 2467 bacteriologically confirmed hospitalized cases and 48 deaths. Most of the country was affected, with 17 of the 18 districts reporting cases. V. cholerae was isolated from 42 per cent of shellfish tested during the epidemic, and an epidemiologic study found that a history of consumption of raw or poorly cooked cockles was significantly more common among cholera patients than among paired controls. Water from a spring and a brand of commercially bottled water were also found to be vehicles of transmission of cholera. Although night soil was sometimes used on gardens, consumption of raw fruits and vegetables was not associated with illness.

cholera; epidemics; mineral waters; shellfish; Vibrio cholerae; water pollution

On April 24, 1974, in Tavira, a town on the southern coast of Portugal, a 33-year-old man developed diarrhea and dehydration so severe that he suffered a cardiac arrest. An alert physician suspected cholera, and the Ricardo Jorge Institute in Lisbon isolated Vibrio cholerae biotype El Tor serotype Inaba from his stool. V. cholerae was subsequently isolated from a Lisbon woman who had contracted a diarrheal illness on May 10 and from a child in Porto on May 14. Within six weeks after the first case, cholera had been reported from eight of Portugal's 18 districts. Eventually 17 of the 18 districts reported cholera, all due to El Tor Inaba organisms. The epidemic peaked the last week in August (figure 1) and then declined rapidly; on November 29, 1974, Portugal was declared free of cholera (1). In this seven-month period 2467 cases and 48 deaths were reported to the World Health Organization (WHO) (2). The case-fatality ratio was 1.9 per cent.

The highest attack rates were reported from districts in the southern half of the country and from Porto, a northern coastal district that includes Portugal's second largest city (figure 2). The attack rates for males and females were approximately equal and tended to increase with age until age 70 (figure 3).

Control measures included individual case investigations by public health nurses, distribution of a two- or three-day supply of tetracycline to all contacts of cholera patients, a massive health education program, and an extensive effort to
promote the chlorination of public water systems. These measures were supplemented by distribution of free bottles of chlorine for disinfection of drinking water from unsafe sources. Cholera vaccine was given only to those who demanded it.

Investigators from the Center for Disease Control and the Portuguese Directorate General of Health carried out studies in Tavira and Faro, two cities on the southern coast, and in Lisbon to determine the important modes of transmission of cholera in Portugal.

**BACKGROUND**

Both Tavira and Faro are separated from the open sea by the Ria de Faro, a complex of islands and mud flats that extends approximately 50 km along the southern coast. Sewage from the coastal towns emptied into the Ria, and water and shellfish in the Ria had high coliform bacteria counts (3). Most shellfish consumed throughout Portugal are caught in this area. After anecdotal information suggested that shellfish had caused some cases of cholera, the Maritime Biology Institute in Faro systematically cultured water and shellfish from the Ria from May to August 1974; *V. cholerae* was isolated from 24 per cent of 121 sea water samples and 42 per cent of 154 shellfish, including clams (44 of 114 positive), cockles (11 of 22), oysters (seven of 15), and mussels (two of three).

Tavira’s municipal water supply was chlorinated, but some residents preferred to drink from two springs in the town. One of these, the Fonte do Bispo, emerged from a pipe in a populated area and had allegedly produced clear water until September 1973 when, following blasting of the rock above the spring and a heavy rain, the water was muddy for a few days. Both springs were closed on May 10 and 11, shortly after the cholera outbreak began, because health authorities suspected that some of the cases might have resulted from drinking from these springs. No water...
from either spring was cultured. Troops traveled back and forth between a military base uphill from the Fonte do Bispo and what were then Portugal's African colonies—Angola, Mozambique, and Portuguese Guinea. Untreated sewage from the base and the town entered the Gilao River, which bisects the city, and flowed with it into the Ria. V. cholerae was isolated from nine of 20 water samples taken from the Gilao River May 14–22, 1974.

In the rural area north of Faro, outbreaks of cholera were attributed by the health authorities to consumption of water from wells, several of which were culture-positive for V. cholerae. The cause of the 59 cholera cases reported in Faro itself in May–September 1974 was unclear, although shellfish were suspect.

In the area around Lisbon, where sewage was sometimes used to irrigate and fertilize vegetable gardens, health authorities initially felt that contaminated raw vegetables, as well as shellfish, might be responsible for most of the cases.

The investigation

Tavira. In Tavira, an attempt was made in October 1974 to locate the 15 cholera patients whose cases were reported during the first four weeks of the outbreak and to question them about their basic demographic data, travel histories, frequency of consuming a variety of foods (including raw fruits and vegetables and seven types of shellfish), methods of cooking shellfish, and sources of drinking water. Neighborhood controls were matched for sex and the same decade of age. Part I of the questionnaire dealt with events in April and May 1974, the months when the cases had occurred. Part II, administered only to cholera patients, limited questions to the five days prior to the onset of illness. The same person interviewed both subjects in each case-control pair.

Fourteen of the first 15 cholera patients were located; although their homes were scattered throughout the town, a matched-pair analysis implicated water from one spring, the Fonte do Bispo, as the probable source of cholera in 11 cases ($p = 0.001$) (table 1). The epidemic curve dropped sharply after the spring was closed on May 10 (figure 4). The other spring was not implicated. Although three patients had eaten raw or semi-cooked cockles in April or May, there was no statistically signifi-
cant association between eating cockles and illness. The first cholera patient was a truck driver who three days before the onset of his illness ate cockles which he had gathered from the Ria de Faro near the mouth of the Gilao river. The cockles were heated until they opened and eaten immediately by three persons. The patient, who took antacids regularly, was the only one of the three who developed diarrhea. He had not been out of Portugal during 1974.

Faro. In Faro, the 59 patients who had V. cholerae isolated from their stools between the beginning of the epidemic in May and the end of September were studied. Patients and age- and sex-matched controls were interviewed using a questionnaire similar to part I of the Tavira questionnaire. The time frame for the questions asked of each case-control pair was a two-month period—the month of onset of illness and the nearest adjacent month.

Fifty-three (90 per cent) of the 59 cholera patients were interviewed and matched. Two different exposures, consumption of brand A commercially bottled mineral water and of raw or semi-cooked cockles, were significantly associated with cholera in the initial analysis. To determine if the two exposures were independently associated with cholera, the associations were reexamined after deleting, for each comparison, pairs in which the patient consumed the other suspected vehicle of transmission (tables 2 and 3). These analyses found that both suspected vehicles were significantly and independently associated with cholera.

Sources of water other than bottled water (public water supplies, cisterns, wells, and springs) were not significantly associated with cholera. For those pairs in which the patient had not consumed brand A bottled water or raw or semi-cooked cockles, the most suspect of these other sources was well water, consumed by

**TABLE 1**

Distribution of 14 case-control pairs by history of drinking at a spring, the Fonte do Bispo, during April and May, 1974, Tavira, Portugal*

<table>
<thead>
<tr>
<th>Case</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Drank</td>
</tr>
<tr>
<td>Drank</td>
<td>0</td>
</tr>
<tr>
<td>Did not drink</td>
<td>0</td>
</tr>
<tr>
<td>Total pairs</td>
<td>0</td>
</tr>
</tbody>
</table>

* Exact test for matched pairs (2-tailed): \( p = 0.001 \).

**FIGURE 4.** The first 15 patients with cholera in Tavira, by date of onset, Portugal, 1974.
seven cases and two controls ($p = 0.180$). No other food items, including raw fruits and vegetables, were associated with cholera. Of the interviewed patients, 49 per cent had eaten raw or semi-cooked shellfish, 17 per cent had consumed brand A bottled water, 19 per cent had consumed well water, and 36 per cent denied having been exposed to these possible sources of infection (figure 5).

**Lisbon.** In Lisbon, a prospective case-control study was done. Beginning September 13, newly diagnosed patients and neighborhood controls matched by age and sex were questioned about exposures during the five days before onset of illness.

### Table 2

<table>
<thead>
<tr>
<th>Case</th>
<th>Ate</th>
<th>Did not eat</th>
<th>Total pairs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ate</td>
<td>0</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Did not eat</td>
<td>2</td>
<td>31</td>
<td>33</td>
</tr>
<tr>
<td>Total pairs</td>
<td>2</td>
<td>42</td>
<td>44</td>
</tr>
</tbody>
</table>

* Excludes 9 pairs in which the patient had consumed brand A bottled water.
† During a 2-month period that included the patient's incubation period.
‡ Exact test for matched pairs (2-tailed): $p = 0.022$.

### Table 3

<table>
<thead>
<tr>
<th>Case</th>
<th>Drank</th>
<th>Did not drink</th>
<th>Total pairs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drank</td>
<td>1</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Did not drink</td>
<td>0</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>Total pairs</td>
<td>1</td>
<td>39</td>
<td>40</td>
</tr>
</tbody>
</table>

* Excludes 13 pairs in which the patient had eaten raw or semi-cooked cockles.
† During a 2-month period that included the patient's incubation period.
‡ Exact test for matched pairs (2-tailed): $p = 0.031$.

![Figure 5](http://aje.oxfordjournals.org/DownloadedFromhttp://aje.oxfordjournals.org) Cholera patients by week of onset, Faro, Portugal, April 27-September 30, 1974.
Thirty-four case-control pairs were interiewed, representing 59 per cent of the 58 cases reported from Lisbon and the adjacent city of Oeiras during the three-week study. There was no significant association between cholera and consumption of bottled water, raw fruits, raw vegetables, or raw or "open" shellfish.

**DISCUSSION**

A 105-year period without reported cholera (4) ended for Portugal in 1971, when that country notified the WHO of an outbreak of 89 cases caused by *V. cholerae* El Tor Ogawa (5). No further cases were reported until the 1974 epidemic, which was caused by the Inaba serotype. The mode of introduction of cholera into Portugal in 1974 is unknown, but the heavy traffic between Portugal and her African colonies where the El Tor Inaba vibrio was endemic suggests that the colonies were the source. North African countries were a less likely source since those countries were reported to have only El Tor Ogawa cholera (6).

The first known case was probably caused by eating contaminated cockles from the Ria de Faro. Although cockles were not implicated statistically in Tavira, three pieces of evidence suggest they were the vehicle of transmission for the first case: 1) the suspect cockles were consumed semi-cooked within three days prior to onset of illness (an appropriate incubation period), 2) cockles from the same area obtained approximately one month later contained *V. cholerae*, and 3) cockles were epidemiologically implicated in nearby Faro City. The antacids regularly taken by the first patient probably reduced his gastric acidity and thereby reduced the dose of *V. cholerae* required to cause illness (7).

The Ria was probably contaminated with the feces of a cholera patient or carrier before April 21, when the first known patient gathered the cockles. One possible source was troops returning from the African colonies to the military base in Tavira. The person or persons who introduced the disease into Portugal need not have been symptomatic; El Tor cholera infections are often asymptomatic, and there may be prolonged excretion of the vibrios in the stool after a symptomatic illness (8).

Fish and shellfish have been reported to cause outbreaks of cholera in the past (9-13), but the evidence was circumstantial until 1973, when mussels were shown to be a vehicle of transmission in case-control studies in Italy (12, 13). Since only one of many samples of shellfish tested in Italy yielded *V. cholerae*, Baine et al. (13) concluded that mussels may have been contaminated after harvesting while being "freshened" with polluted seawater while on sale. In contrast, in Portugal, where epidemiologic investigation demonstrated that consumption of cockles caused some cases of cholera, both shellfish and seawater samples from the shellfish beds were heavily contaminated with *V. cholerae* during the 1974 epidemic. Clams could not be epidemiologically associated with cholera in these investigations, although *V. cholerae* was isolated from 39 per cent of clams tested and anecdotal information suggested that clams caused some cases of cholera. To prevent future transmission of cholera by shellfish, Portuguese authorities have accelerated plans for construction of sewage treatment facilities, and have instituted a program that routinely samples seawater from 25 points along the southern coast; cultures of seawater for *V. cholerae* from September 1974 to June 1975 were negative.

In reviewing cholera research performed prior to 1959, Pollitzer recorded one outbreak of cholera associated with a contaminated spring (14); the spring water was apparently contaminated after it emerged from the ground into a pool (15). In Tavira, the implicated spring was probably contaminated underground. The blasting of the rock above the spring during construction may have allowed pollution of the spring by sewage containing feces from
persons who had eaten contaminated shellfish or from troops at the nearby military base.

Water has been implicated repeatedly as a vehicle of transmission in cholera outbreaks, but commercially bottled water has not been incriminated previously. The association of brand A bottled water with cholera was confirmed in a subsequent study in Lisbon (21).

Fruits and vegetables contaminated by sewage or polluted water were initially suspected to be vehicles of cholera transmission in Portugal, but no association was found between cholera and the consumption of these items. A few reports suggest that contaminated raw fruits and vegetables may have caused cholera outbreaks in other countries (16, 17), laboratory studies have shown that vibrios can live on fruits and vegetables for several days (18, 19), and V. cholerae was isolated from one of 344 samples of vegetables during a cholera outbreak in Israel (20); however, these foods have not been conclusively implicated as vehicles of cholera transmission.

Why the disease spread so rapidly throughout Portugal is unknown; it is not even certain that the disease began on the southern coast, since asymptomatic or unrecognized cases elsewhere may have preceded the first diagnosis. An attractive hypothesis is that contaminated shellfish shipped from the Ria de Faro caused a few cases in many different areas, and the excreta of these persons contaminated the environment with vibrios whose subsequent transmission involved many different vehicles. Three different vehicles of transmission were demonstrated in these investigations—spring water, bottled water, and cockles—and contaminated wells and other types of shellfish may also have caused cases. It is probable that there were other vehicles of transmission, but we could not ascertain these during investigations carried out during the declining phase of the epidemic.

REFERENCES