

# The spread and control of cholera in Bangladesh

by M.S. Islam and O.M. Bateman

**While researchers are learning more and more about the cholera bacterium, improvements in sanitation and hygiene behaviour are still the best defence.**

CHOLERA HAS A long history of causing life-threatening epidemics, and it continues to do so even now. In 1991, when the seventh cholera pandemic reached Latin America, there were 391 220 reported cholera cases with 4002 deaths. In the same year in Bangladesh, there were an estimated 210 000 to 235 000 cases and over 8000 deaths in the months of September, October, and November alone.<sup>1</sup> Historically, cholera epidemics have been caused by *Vibrio cholerae* O1, either the 'Classical' or 'El Tor' biotype. The seventh pandemic and the majority of the cases reported in 1991 were caused by El Tor.

More recently, an epidemic of non-O1 *V. cholerae*, the first described of

its kind, began in southern India and spread around the coastal areas of the Bay of Bengal to Bangladesh, and subsequently to many other countries. While the 'new' cholera organism differs serologically from the previous epidemic-causing *V. cholerae* O1 organisms, early evidence suggests that the new organism, called *V. cholerae* O139-Bengal, is similar to Classical and El Tor cholera in terms of the clinical disease it causes, its transmission pattern, and its epidemiology, but previous exposure to both El Tor and Classical cholera provided no immunity to O139-Bengal, and there were a high number of cases as the first epidemic wave swept through. The O139-Bengal epidemic entered south-

ern Bangladesh in late 1992, and by the end of March 1993 over 107 000 cases of severe diarrhoea and 1473 deaths had been reported.

Cholera is generally understood to be transmitted by the faecal-oral route, that is from the faeces of an infected individual, then through water, food, or other means to the mouth of a new, susceptible individual. The means to prevent such transmissions are well understood, yet cholera epidemics continue to flourish. Why is this so? In part, it is because of high population growth, high population density, and poverty, and it occurs where water services, sanitation services, and hygiene improvements lag far behind need. There is new evidence, however, that suggests that the role of the environment in maintaining endemic and epidemic cholera is more complex than previously thought.

## Cholera seasonality

Cholera is endemic in Bangladesh and maintains a regular seasonal pattern with two peaks — one in the hot season, from March to April, and the other in the post-monsoon season, from September to January.<sup>2</sup> The etiologic agent *V. cholerae* can be isolated from patients as well as from the aquatic environment during epidemics, but disappears from surface waters after the epidemics are over. The reservoirs or sites of survival and multiplication of these pathogenic vibrios during inter-epidemic periods were unknown. Recent laboratory and field studies, however, have demonstrated that *V. cholerae* O1 can survive inside the mucilaginous sheath of a blue-green alga, *Anabaena variabilis*, for more than a year. These blue-green algae are now considered to be a reservoir of *V. cholerae* in the aquatic environment,<sup>3</sup> and the cholera season in Bangladesh is related to the seasonal algal bloom formation.<sup>4</sup>

During algal blooms in epidemic periods, the algae die and disintegrate. The *V. cholerae* O1 which survived in the mucilaginous sheath are released, and are in favourable conditions for multiplying in surface water. They get glucose, calcium, magnesium salts, etc. from the decomposition of the mucilaginous sheaths of the blue-green algae. During algal blooms, both the pH and the salinity of the water increases, which also favours the growth of *V. cholerae*. Under all these favourable conditions,



WHO/JL Ray/AKF

*Cholera continues to flourish, in part because of high population growth and density, poverty, and a lack of water and sanitation services.*



IT/Neil Cooper

*Cholera may also be transmitted through the consumption of contaminated fish, oysters, crabs, or other shellfish.*

the rapid multiplication of *V. cholerae* O1 takes place, and the water becomes heavily contaminated.

## Transmission

**Primary transmission** Cholera may be transmitted from the aquatic environment to humans in a number of ways. During epidemic seasons, *V. cholerae* multiply in the aquatic environment. This may be triggered by the multiplication of blue-green algae and other favourable conditions in the aquatic environment, as described earlier. When people interact with the heavily contaminated surface water ponds, lakes, canals, or rivers to bathe, wash, and, sometimes, to drink, it is then that they may contract the disease. This may be the primary mechanism by which the cholera organisms are transmitted from the aquatic environment to humans. The transmission may also occur through the consumption of contaminated fish, oysters, crabs, or other shellfish.

Studies have shown that the incidence of cholera in fishing communities in Bangladesh is higher than in farming communities. It is likely that one individual contracts the disease during a fishing expedition, which often lasts for several days, when the surface water is used by the fishermen for all purposes, including drinking. The fish that are caught are left in the boat without refrigeration, where they often deteriorate and become contami-

nated. The fishermen often sell the best fish in the market and take the unsold, spoiled fish back home for eating. Even though this fish may then be well cooked, improper handling can lead to the contamination of kitchen utensils and other foodstuffs.

There are a number of reports from several cholera epidemics about the different kinds of fish which act as the vehicle for introducing *V. cholerae* O1 from the aquatic environment to the human population.<sup>5</sup>

**Secondary transmission** Once the organisms are brought to the community and get a foothold via an index case (the first individual to catch the disease), cholera then spreads to the surrounding population by all the common modes of faecal-oral transmission. This continued spread is usually a result of inadequate water and sanitation services and poor personal and domestic hygiene practices. It has been demonstrated, for example, that when a family member develops cholera, a quarter of that family's contacts may develop cholera within days, and at least an additional quarter may have asymptomatic cholera infections because of poor hygiene practices.

## Defecation and transmission

One of the main means of spreading cholera from infected people to the

surrounding population in developing countries is through indiscriminate defecation. In Bangladesh, as in many countries, people who have no access to latrines usually defecate on the banks of ponds, canals, or rivers, where water is readily available for washing afterwards. Those who can afford to build low-cost latrines often build hanging latrines, also on the banks of ponds, canals, or ditches. The same water bodies that are contaminated by open defecation or hanging latrines are also used for personal, domestic, and household purposes, including bathing, washing, swimming, cooking and, occasionally, drinking.

The photo on page 22 illustrates a typical scene in which hanging latrines are located on the bank of a water source, and where people are using the same water source for a variety of purposes. It is easy to see how these sorts of water and sanitation practices help to maintain a cycle of *V. cholerae* in the population and the nearby water sources.

A number of studies have shown that contaminated surface water is important in the transmission of *V. cholerae* in the environment. It was found that once cholera was introduced into a neighbourhood (by whatever means), its subsequent spread was associated with the use of polluted surface water sources shared by households in the neighbourhood. It was found that the proportion of contaminated water sources used by the index



WHO Photo

The same water source is used for washing clothes, bathing, fishing, defecating, and as a source of drinking-water.

case and neighbouring households during the 12-day study period were 68 per cent of tanks, 46 per cent of canals and rivers, 44 per cent of ditches, and 0 per cent of tubewells. Overall, 57 per cent of all surface water sources contained *V. cholerae*. The proportion of stored water in the households that was contaminated included 10 per cent of the stored drinking-water from surface sources, and 13 per cent of the stored cooking water from surface sources. It was found that intra-neighbourhood and intra-family cholera transmission was primarily via contaminated surface water.

### Environmental interventions

Cholera can be transmitted through contaminated water or food and from person to person, though the primary route is water-borne transmission. In all cases, the primary barrier to the faecal-oral transmission of cholera is to keep the cholera organism out of the environment in the first place. This can only be achieved by disposing of faeces in a sanitary way so that the cholera-containing faeces do not contaminate water bodies or the environment. What may distinguish cholera from other diarrhoea-causing organisms is the additional risk of a person becoming infected with *V. cholerae* from the natural aquatic reservoir, as

described earlier. Figure 1 shows how susceptible people in a community may become infected, either through exposure to the natural aquatic reservoir or via faecal-oral transmission (similar to many other diarrhoea-causing organisms).

The existence of two possible routes of infection with *V. cholerae*, the aquatic reservoir and faecal-oral routes, and the ability of *V. cholerae* to multiply rapidly in water, add additional dimensions to cholera control efforts in areas where communities have access to surface water bodies. For the interruption of faecal-oral transmission, the primary barrier is adequate sanitation to keep contaminated faeces out of the environment. When this primary barrier is absent or imperfect, personal and domestic hygiene behaviour must be improved to avoid or destroy contaminating organisms and to prevent transmission in households and in the community. This behaviour includes water-source selection, water storage and handling behaviours, food hygiene, and hand-washing.<sup>6</sup>

A study in Bangladesh found that lower grade government employees living in government quarters provided with sanitary latrines and a piped water supply experienced cholera frequently, whereas the upper grade employees, also living in government quarters and provided with sanitary latrines and piped water supply, almost never

contracted cholera. Similarly, people living in upper-class residential areas of Dhaka never contracted cholera in the midst of even the most severe epidemics. The main differences between the upper and the lower-income groups were in the personal and domestic hygiene practices.<sup>7</sup> Epidemic cholera cannot be prevented by the provision of clean water and sanitation alone; appropriate hygiene behaviour changes must accompany the provision of hardware.

In the case of *V. cholerae*, adequate sanitation and improved hygiene alone may be expected to have less effect on transmission than in the case of diarrhoea-causing organisms that rely exclusively on faecal-oral transmission. With an aquatic reservoir, susceptible individuals may continue to be at risk of infection, even if faecal-oral transmission is completely interrupted. The obvious means of avoiding such transmission, that is drinking only water from a clean source such as a deep tubewell or chlorinated, piped water, is also a cornerstone of the prevention of faecal-oral transmission. While one may speculate about additional measures to avoid the transmission of cholera from aquatic reservoirs, the first step is to avoid using unsafe surface water for personal and domestic purposes. In summary, interrupting the spread of cholera involves several long-term interventions. Priority meas-

ures to control cholera transmission include:

- The use of water from clean sources only, for all personal and domestic purposes. This will involve ensuring convenient access to abundant quantities of protected or piped water.
- Improved water handling and storage to prevent the contamination of water between the source and the point of consumption. This may involve improved containers or small-scale technologies such as putting spigots on tanks, as well as changes in behaviour.
- Where abundant quantities of clean water cannot be assured in the short term, specific high-risk water-related behaviour should be targeted to reduce the risk of cholera transmission in the interim, while long-term issues of adequate access are being addressed.
- Improved sanitation to interrupt the epidemic spread of *V. cholerae*. This includes access to a sanitary latrine and its use by all of the community members, all of the time, to prevent the faecal contamination of the environment.
- Adequate food hygiene, including preparation, storage, serving, and eating.
- Adequate personal hygiene, particularly handwashing.

Finally, it must be re-emphasized that in most settings the prevention of cholera cannot be achieved by technical or hardware interventions alone, but changes in behaviour must also take place. With this in mind, cholera control efforts should include strong, locally appropriate hygiene education components. ●

### Acknowledgements

This work was supported by the International Centre for Diarrhoeal Disease Research, Bangladesh. The ICDDR,B is supported by countries and agencies which share its concern for the health problems of developing countries. Current donors include: the aid agencies of the governments of Australia, Bangladesh, Belgium, Canada, Denmark, Japan, The Netherlands, Norway, Saudi Arabia, Sweden, Switzerland, the United Kingdom, and the United States; international organizations including Unicef, UNDP, the UN Population Fund, WHO; and private foundations, including the Ford Foundation and the Sasakawa Foundation.

We thank Mr Manzurul Haque for secretarial assistance.

### References

1. Siddique, A.K., Zaman, K., Baqui, A.H., Akram, K., Mutsuddy, P., Susof, A., Haider, K., Islam, S., and Sack R.B. 'Cholera epidemics in Bangladesh: 1985-91'. *Journal of Diarrhoeal Disease Research*, 10, pp.79-86, 1992.
2. Islam, M.S., Drasar, B.S., and Sack, R.B., 'The aquatic environmental as a reservoir of *Vibrio Cholera*: A review'. *Journal of Diarrhoeal Disease Research*, 11, pp.197-206, 1993.
3. Islam, M.S., Drasar, B.S., and Bradley, D.J.,

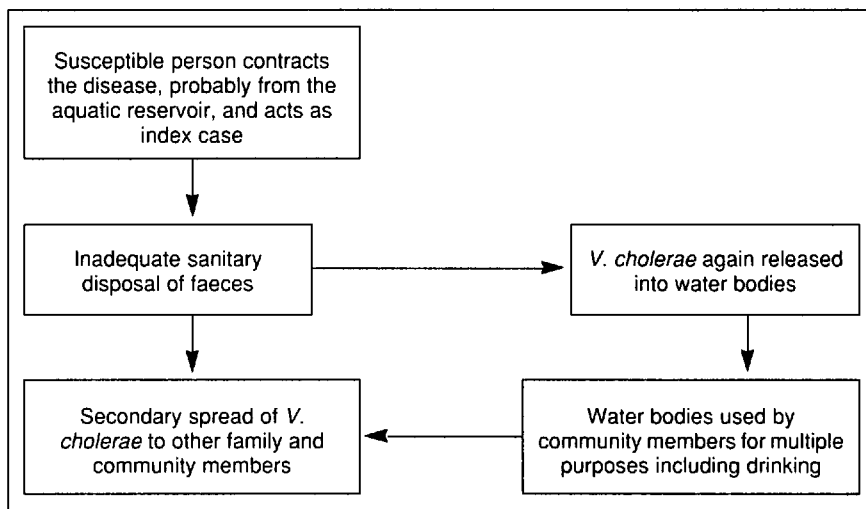


Figure 1. The aquatic environment and transmission of *V. cholerae*.

- 'Long-term persistence of toxigenic *Vibrio cholera* 01 in the mucilaginous sheath of a blue-green algae, *Anabaena variabilis*', *Journal of Tropical Medicine and Hygiene*, 93, pp.133-9, 1990.
4. Cockburn, T.A. and Cassanos, J.G., 'Epidemiology of endemic cholera', *Public Health Reports*, 75, pp.791-803, 1960.
  5. Feacham, R.G., 'Environmental aspects of cholera epidemiology. I. A review of selected reports of endemic and epidemic situations during 1961-80', *Tropical Diseases Bulletin*, 78, pp.675-98, 1981.
  6. Bateman, O.M., 'Diarrhoea transmission and domestic hygiene behaviour: Personal and domestic hygiene'. Presented at a WHO

informal consultation on improved water and sanitation hygiene behaviours for the reduction of diarrhoeal diseases, Geneva, 18-20 May 1992.

7. Khan, M.W. and Shahidullah, M., 'Role of water and sanitation in the incidence of cholera in refugee camps', *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 76, pp.373-7, 1982.

M.S. Islam is an Associate Scientist in the Laboratory Sciences Division, and O.M. Bateman is an Epidemiologist in the Community Health Division of the International Centre for Diarrhoeal Disease Research — Bangladesh, GPO Box 128, Dhaka 1000, Bangladesh.

## Health Education for Water and Sanitation Programmes

*An intensive one-week course for professionals working, or intending to work in developing countries*

This course is held regularly at the Robens Institute, University of Surrey and focuses on the development of appropriate strategies and methods of community health education in developing countries. It is particularly appropriate for those professionals who work or are likely to work on water, sanitation and hygiene projects.

The principle areas of study include:

- The role of health education in water, sanitation and hygiene programmes
- Health education strategies
- Participatory learning methods
- Planning health education programmes

The course can also be offered in-country with the option for an additional week of study.

**The next course runs 12-16 September 1994.**

For further details on this and other courses please contact:

Jennie Lynch  
Environment Division  
Robens Institute  
University of Surrey  
Guildford  
Surrey GU2 5XH  
UK



World Health Organization  
Collaborating Centre for the  
Protection of Drinking Water  
Quality and Human Health

Tel: 0483 259209; Fax: 0483 503517; Telex: 859331 UNIVSY G.