



Water Quality vs. Sanitation Accessibility

What is the most effective intervention point for cholera in Dhaka, Bangladesh?

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Abstract

Every year, 3 to 5 million individuals contract cholera, an acute diarrheal infection that is caused by ingestion of food or water that contains the *Vibrio cholerae* bacteria. The bacterium originates in brackish seawater, and as a result remains endemic in many developing, coastal countries (Figure 1) (WHO 2008). Because cholera is a waterborne disease, it can be transmitted quickly in environments with inadequate sewage and sanitation systems where infected waste can easily pollute the drinking water. Water and sanitation infrastructure, both of which are indicators of socioeconomic status, are crucial determinants for the transmission of cholera (Chapra 2010; Okun 1988). Because of the inadequacy of these factors and its proximity to the Bay of Bengal (Figure 2), Bangladesh continues to struggle with cholera, producing upwards of 1 million cases per year (WHO 2008). Cholera prevention interventions must be implemented to curb treatment expenses and wages lost to illness. Preliminary analysis of cholera incidence data from the International Centre of Diarrheal Disease Research, Bangladesh suggests that boiling of drinking water is more protective against cholera than use of a sanitary latrine or high household income. By extrapolation, water quality interventions are more critical to cholera prevention than sanitation and socioeconomic development initiatives. These results may have significant implications on how Bangladesh and its benefactors will allocate their funds for the purpose of nationwide cholera prevention.



D+ L+ I+ = 449
D+ L+ I- = 240
D+ L- I+ = 45
D+ L- I- = 83
D- L+ I+ = 402
D- L+ I- = 661
D- L- I+ = 225
D- L- I- = 751

Table 1. Tabulation of preliminary analysis data.

Variable Legend:	
D+	Boiled drinking water
D-	Did not boil drinking water
L+	Used sanitary latrine
L-	Did not use sanitary latrine
I+	High household income (>5000 Tk*/month)
I-	Low household income (<5000 Tk*/month)

*Abbreviation for taka, the national currency of Bangladesh (exchange rate: 1 USD = 70 Tk.)

Table 2. Variable legend for Table 1.

Background

The ICDDR, B (International Centre of Diarrheal Disease Research, Bangladesh) is an international health research and treatment facility that consists of two locations: the urban capital of Dhaka (main campus) and the rural village of Matlab. Pursuing cholera research since 1960, ICDDR, B is credited with the discovery of oral rehydration as the principal treatment for dehydration in 1969. However, as more severe strains of cholera begin to propagate in Bangladesh, ICDDR, B's primary contribution to the society is their clinical facilities (Siddique et al. 2010). The institution's free hospitals in both locations have provided treatment to hundreds of thousands of diarrheal disease patients in the past 50 years, reducing the mortality from cholera in the country to less than 1%. Surveillance teams at either location consistently administer interviews to 1 out of every 50 patients. The interview is comprised of demographic, behavioral and socioeconomic questions; thorough physical examinations; and microbe and pathogen testing (via stool sampling). Such surveillance has yielded two of the most comprehensive and meticulously maintained disease incidence databases in the world—one in Matlab, and the other in Dhaka.

Methods

Principle Research Question:

In order to reduce disease incidence, what is the most effective point of intervention for cholera patients seen at the ICDDR, B clinic in Dhaka, Bangladesh?

Dataset obtained from ICDDR, B:

10 years of cholera incidence data as obtained from surveys administered at the Dhaka clinic (1/50 sequential sampling), from 2000 to 2009

Variables of interest:

- 1) Use of sanitary latrines
- 2) Monthly household income
- 3) Boiling of drinking water

Why were these variables chosen?

The three most commonly referenced determinants of cholera are access to sanitation, socioeconomic status, and water quality (Emch 1999; Hurt et al. 2004). The variables of interest serve as surrogates for these determinants.

The question then becomes: Which of these three variables of interest is most protective against cholera?

Preliminary Analysis

The three hypotheses presented below were derived from the current literature and tested by analyzing the dataset obtained from ICDDR, B (Table 1 and 2). The defenses represent preliminary analysis only and should not be considered as final results. The ICDDR, B implements a rigorous quality control regimen, and this preliminary analysis is currently in process.

Hypothesis 1: Not boiling drinking water, low monthly household income, and not using a sanitary latrine can account for the majority of cholera cases in the sample (Derived from Emch 1999; Hurt et al. 2004; Okun 1988).

Defense:

D- U L- U I- = 2407

Total Cholera Patients = 2856

2407/2856 = .843 → 84.3% of cases can be accounted for by these three variables alone.

There are other known means of cholera transmission, including the ingestion of food contaminated with cholera, that are not included in my data set (Dubois et al. 2006). Such means may account for the remaining 15.7% of cholera cases in the sample.

Hypothesis 2: High household income is more critical to cholera prevention than usage of sanitary latrines (Derived from Emch 1999).

Defense: The (D+ L+ I-) subgroup essentially tells us how many individuals developed cholera because they had a low household income; these cholera patients drank boiled water, used sanitary latrines, but were poor. This number is 240. The (D+ L- I+) subgroup tells us how many individuals got cholera because they did not use sanitary latrines; these cholera patients drank boiled water, came from high-income families, but did not use a sanitary latrine. This number is only 45. As such, high household income is more critical to cholera prevention than usage of sanitary latrines.

Hypothesis 3: Boiling of drinking water is more protective against cholera than usage of sanitary latrines and high household income. (Derived from Sack 2003; Sobsey 2010; Taha et al. 2000)

Defense:

-The number of cholera patients that did not drink boiled water (total, including other two variables) is 2039. That is 71.4% of total cholera cases.

-The (D- L+ I+) subgroup tells us how many individuals got cholera because they did not drink boiled water; these cholera patients used sanitary latrines, came from high-income families, but did not drink boiled water. This number is 402, nearly 10x the number of cases that occurred due to not using a sanitary latrine and over 1.5x the number of cases that occurred due to low household income.

Conclusions

At the individual level, boiling of drinking water is a more effective cholera prevention method than use of a sanitary latrine or high household income. Therefore, water quality is more critical to cholera prevention than access to sanitation and socioeconomic status. Water quality is the intervention point for cholera in Dhaka, Bangladesh.