Cholera in Haiti: Fully Integrating Prevention and Care

The first cases of cholera after the 2010 earthquake in Haiti were reported in the Centre department; 4 months later, 215 936 cases had been reported across all 10 of Haiti's geographic departments, and among these, 1.9% (4131) of patients died (1). Because reporting capacity is weak in Haiti, these statistics probably underestimate the number of cases of cholera and the rate of spread. In the first months of the epidemic, case-fatality rates varied by 10-fold across departments, ranging from 0.8% to 8% (2) (**Table**). For this reason, the article by Tuite and colleagues in this issue (3) is timely and important.

The investigators used a mathematical model that considers both waterborne and person-to-person transmission of cholera to predict the spread of the disease in Haiti. This "gravity" model predicts rates of disease transmission among regions on the basis of the population of a department and distance between departments. The model also attempts to assess the effects of 2 distinct interventions: vaccination on a limited scale and provision of clean water at the same scale. Tuite and colleagues posit that administering a limited supply of 2-dose vaccines to 500 000 individuals would reduce risk by 3%—twice the risk reduction that would stem from provision of clean water to the same number of individuals.

Although we believe that these results probably underestimate the effect of both interventions, several conclusions can be drawn from this exercise. First, projections from the model show that morbidity and mortality during the epidemic phase of cholera is likely to last well into 2011. This may in fact be an optimistic prediction for the course of the epidemic phase; as has been argued elsewhere, cholera may become endemic in Haiti (4). Second, by showing the greater effect of earlier vaccination, Tuite and colleagues' study helps bolster the argument for initiating and expanding cholera vaccination in Haiti as soon as possible. Although vaccines can be effective even with limited use, broader and earlier intervention leads to greater risk reduction, highlighting the need for a global stockpile of cholera vaccine to respond rapidly to epidemics. Third, the dual approach of vaccination and clean water illustrates the positive synergies of a comprehensive strategy that combines multiple interventions.

In the context of economic scarcity, debate invariably arises about the relative merits of investment in prevention versus care. Such debates about setting priorities in the face of a new epidemic are not new. However, they weigh the value of competing interventions when in fact complementary ones are needed. Cholera is no exception, and Tuite and colleagues' model is useful in assessing different approaches, including vaccination strategies based on the concentration of cases and the expected spread of the disease (for example, whether the same number of doses should be given to each area or whether distribution should be proportionate to population size). Such models can guide policymakers and administrators in designing optimal public health interventions.

Mathematical models such as these can also be useful in tracking the nature and time course of an epidemic when surveillance efforts are constrained. Authorities have reported shortcomings in Haiti's monitoring system (Thimothe G. Personal communication. 2011), which was weak even before the earthquake leveled most of Haiti's federal government infrastructure, including the Ministry of Health. The very low numbers of nonhospitalized case fatalities strongly suggest that current monitoring efforts fail to capture many cholera victims, particularly in rural areas, where cases are underreported and often untreated (**Table**). Although the first cases of cholera were detected fairly quickly—a credit to the beleaguered Ministry of Health—the numerous nongovernmental organizations and international assistance groups that provide health services have made centralized collection of case data through the Ministry of Health challenging (5), despite the goodwill of and substantial assistance from partners ranging from the Cuban medical brigades to the U.S. Centers for Disease Control and Prevention.

How should policymakers make decisions that are informed by honest assessment of both local capacity and new technologies, including vaccines? Decision analysis might prove useful in public health decision making and help to determine what resources should be invested to enhance the availability of clean water, diagnose and treat cholera, and distribute vaccines. Yet, these should not be envisioned as competing strategies (6). Because cholera is part of a vicious cycle of poverty, poor sanitation, water contamination, and a weak health system, we argue for an approach that combines prevention and care at every step.

Table. **Geographic Variation in Cumulative Cases of and Deaths From Cholera in Haiti, 20 October 2010 to 2 February 2011***

Department or City	Total Cases, *n*	Hospitalized Case Fatalities, *n*	Nonhospitalized Case Fatalities, *n*	Case-Fatality Rate, %
Artibonite	59 937	550	313	1.4
Centre	18 958	180	173	1.8
Grande'Anse†	13 026	324	521	6.2
Nippes	1904	52	83	6.8
Nord†	25 499	576	43	2.4
Nord-Ouest	15 222	169	68	1.6
Nord-Est	7922	104	144	3.1
Ouest‡	12 854	164	77	1.9
Port-au-Prince	53 621	412	16	0.8
Sud†	7532	138	45	2.4
Sud-Est	2117	34	148	8.0

* Data are from reference 2.
† Complete data were not available.
‡ Excluding Port-au-Prince.

On the basis of our experience combining treatment of tuberculosis and AIDS in Haiti, "vertical programs" can have substantial, positive collateral effects in strengthening health systems (7).

Tuite and colleagues' model is promising in its ability to predict the course of the cholera epidemic in Haiti. However, its ability to gauge the reduction in spread on the basis of the relative contribution of specific interventions implemented at scale is less certain. The investigators' prediction of a modest effect of interventions must be considered in light of existing models, both of cholera prevention and other vertical interventions designed to strengthen health systems. A recent model of cholera vaccination by Reyburn and associates (8) showed that widespread rapid vaccination in previous epidemics in the past decade may have averted 40% of cases and deaths. Reyburn and associates also determined that even a "reactive" cholera vaccination campaign with 50% coverage could have prevented more than 10 000 cases of the disease in Zimbabwe in 2008 and 2009. Furthermore, a study in Bangladesh demonstrated through stochastic modeling of cholera transmission that vaccinating 50% of the population would result in a 93% reduction in cholera incidence across the group (9). These studies took into account both direct protection to vaccine recipients and indirect benefits for the broader community. If we consider the demonstrated effects of herd immunity, the potential benefits of vaccination are even greater (10). The short- and long-term effects of these interventions may exceed those predicted by Tuite and colleagues' model.

Although the challenges to implementation of a cholera vaccination program are substantial, the hurdles are far lower than those posed by many vaccines, given that an oral cholera vaccine exists and no buffer is required (although a cold chain is necessary). For example, 76% of girls who completed a 3-dose course of human papillomavirus vaccine administered by Partners In Health in rural Haiti received their second 2 doses after the 2010 earthquake (11). Although this is a modest example, it is almost twice the rate of completion for similar courses in U.S. settings (12) and demonstrates the feasibility of vaccination (involving both refrigeration and injection in this case) in resource-poor, postdisaster settings.

Provision of clean water involves various short- and long-term approaches and effects that are not included in this model. These interventions range from chlorine tablets and cloth filtration (13) to point-of-use water purification tools (14) and functional municipal water systems through Haiti's public sector. Clean water is a fundamental public health necessity that affects many outcomes beyond cholera-specific morbidity and mortality. Almost a decade before the 2010 earthquake, Haiti was ranked last out of 147 countries on the Water Poverty Index (a measure of water security), with 70% of the population lacking access to clean water (15–17).

As the model created by Tuite and colleagues suggests, there is little reason to believe that cholera will disappear from Haiti in the near future. In fact, if cholera becomes endemic in Haiti, which seems likely, it will present a lasting threat to other countries in the region. Surveillance must be part of any comprehensive response to the immediate epidemic and become a cornerstone of the country's overall health infrastructure. Education, prevention, a secure supply chain, and treatment efforts can and must be integrated. As prevention and treatment interventions are expanded, evidence on their efficacy should guide future implementation strategies to ensure that they are maximally effective. Such mechanisms should also strengthen Haiti's health system in general, giving the country tools to respond to future health crises.

The challenge of cholera in Haiti reveals the biosocial complexity before us. A comprehensive strategy that ranges from oral and intravenous rehydration and antibiotic therapy to strengthening Haiti's public water and sanitation systems, while also including vaccination, is the best way to limit the spread of cholera in Haiti. With Haitian leadership and continued support from nongovernmental organizations and standard-setting bodies, we must link prevention to care by not only rolling out a large-scale vaccination campaign but also improving surveillance and tying educational campaigns (about hand washing, for example) to delivery of needed resources (such as soap) and improved treatment. All of this must be done in a way that responds to the acute problem of cholera while also strengthening Haiti's weakened health care system.

As Tuite and colleagues duly note, it is important not to let mathematical models render our thinking deterministic. By offering us a picture of the opportunity cost of inaction, such models provide a clear motivation for quick and robust intervention. There remains great hope that the thousands of deaths predicted by these models can be averted.

David Walton, MD, MPH
Arjun Suri
Paul Farmer, MD, PhD
Harvard Medical School
Boston, MA 02115

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Requests for Single Reprints: Paul Farmer, MD, PhD, Department of Global Health and Social Medicine, Harvard Medical School, 641 Huntington Avenue, Boston, MA 02115.

Current author addresses are available at www.annals.org.

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Current Author Addresses: Drs. Walton and Farmer and Mr. Suri: Department of Global Health and Social Medicine, Harvard Medical School, 641 Huntington Avenue, Boston, MA 02115.