Perspective Piece

Yemen in a Time of Cholera: Current Situation and Challenges

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Abstract. Since early 2015, Yemen has been in the throes of a grueling civil war, which has devastated the health system and public services, and created one of the world's worst humanitarian disasters. The country is currently facing a cholera epidemic the world's largest on record, surpassing one million (1,061,548) suspected cases, with 2,373 related deaths since October 2016. Cases were first confirmed in Sana'a city and then spread to almost all governorates except Socotra Island. Continued efforts are being made by the World Health Organization and international partners to contain the epidemic through improving water, sanitation and hygiene, setting up diarrhea treatment centers, and improving the population's awareness about the disease. The provision of clean water and adequate sanitation is imperative as an effective long-term solution to prevent the further spread of this epidemic. Cholera vaccination campaigns should also be conducted as a preventive measure.

Yemen has been devastated by a brutal war which started in early 2015. Twenty one million people (75% of the total population) require humanitarian assistance, 7.3 million are severely food insecure, and 3.3 million are internally displaced.¹ Moreover, the health-care system is on the brink of collapse as more than 55% of health facilities are partially functioning or destroyed.¹ This situation, which is already a complex web of challenges, is exacerbated by the airport closures, severe shortages of fuel, food, drinking water and medication, and nonpayment of public employees for 15 months since September 2016 (Figure 1A). In addition, sewage and drainage systems are clogged and rubbish is piled high in the streets (Figure 1B). The underground water in all Yemeni cities is contaminated with sewage and treatment plants are not functioning because of lack of fuel and maintenance.²

A total of 1,061,548 suspected cholera cases and 2,373 related deaths were recorded in a two-wave epidemic which was reportedly due to *Vibrio cholerae* O1, serotype Ogawa (Figure 2).³ The epidemic started on October 2, 2016 and there were 25,872 suspected cases and 129 deaths (case fatality rate [CFR] = 0.50%) by April 26, 2017.⁴ Early on, the cases were predominantly in Sana'a city and then spread to 15 of the country's 23 governorates (135 of 333 districts). The epidemic peaked in week 50/2016 (December 12–18), with about two-thirds of the cases reported in Aden, Al-Bayda, Hodeidah, and Taiz, then declined steadily, with only 88 suspected cases reported in week 10/2017 (March 6–12).

However, a second, much more severe wave of cholera started on April 27, 2017. Since then, more than one million (1,035,676) suspected cases and 2,244 related deaths (CFR = 0.22%) were reported by January 14, 2018, with almost half (43.2%) of 27,047 suspected cases testing positive by a rapid diagnostic test and 41.1% of 2,679 cases showing a positive culture for *V. cholerae* O1.⁵ Within a few weeks of cases re-surging in Sana'a city, the epidemic had reached 22 of the country's 23 governorates (305 of 333 districts). More than 50% of the cases were in Hodeidah, Hajjah, Sana'a city, Amran, and Dhamar governorates, with Hodeidah having the

highest number (150,965) of suspected cases, whereas Hajjah had the highest number (420) of deaths (Figure 3). Overall, children aged below 18 years represent about 60% of total suspected cases, with those aged below five represent about 29%, whereas people aged older than 60 years are at most risk of dying, accounting for about one-third of associated deaths.⁶

Unfortunately, health facilities cannot accommodate more patients with acute watery diarrhea and many are lying in corridors on intravenous drips. Some are even in their cars with their drip hanging out of the window or in health facility grounds with drips hanging over trees and windows (Figure 1C). A state of emergency was declared in Sana'a city on May 14, 2017 and the government has appealed to the international community for assistance to save the lives of its people. According to United Nations Office for the Coordination of Humanitarian Affairs, this cholera epidemic in Yemen is currently the worst cholera epidemic in the world.¹ It is believed that the statistics are an underestimation and that the death toll will increase dramatically because of delays in seeking treatment due to poverty, transport difficulties, and the tendency to use self-medication and traditional medicine to treat diarrhea (59.2% of deaths were severe cases at admission).⁵

With a plan to commence a targeted mass vaccination campaign in July 2017, the World Health Organization (WHO) and the government of Yemen requested 3.5 million doses of cholera vaccine. Accordingly, the International Coordinating Group on vaccine provision decided to dispatch one million doses of cholera vaccine to Yemen, and this amount was almost half of the available global stockpile.⁷ However, unfortunately, the vaccination campaign has been scrapped, and the shipped vaccines have been reallocated to other countries. In a press release explaining the decision, Yemeni government, United Nations, and WHO spokesmen stated that the decision was a technical one to ensure that efforts would be focused on a water, sanitation and hygiene (WASH) intervention to provide safe water and sanitation to about 16 million people who currently lack access.⁸ Referring to the sheer scale of the epidemic and the security situation, it was also stated that it might be too late for vaccination and the benefits did not outweigh the risks of commencing a campaign.

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FIGURE 1. (A) People gather to collect drinking water from a charity tanker truck in the midst of the cholera epidemic in Taiz governorate, (B) rubbish piles up on a main street in Sana'a city, and (C) cholera-infected patients lie on the ground while receiving treatment at a temporary health station in Hajjah governorate, Yemen. This figure appears in color at www.ajtmh.org.

There is a debate on cholera vaccination in Yemen that centers on the following critical question: "If you had one million doses of vaccine, who would you try to protect?" Moreover, some have pointed out that vaccine confers protection only to those who have not yet been infected and is

best given in areas of low risk. Nonetheless, there is no evidence to support such a statement and there is no harm in vaccinating those who have recently been infected.⁹ In fact, there is great benefit to the vulnerable population as the risk of acquiring infection is highest during outbreaks and people

FIGURE 2. Epidemic curve of cholera cases in Yemen (A) October 2016–April 26, 2017 (first wave) and (B) April 27, 2017–December 31, 2017 (second wave). Reprinted from "Cholera situation in Yemen, December 2017,"³ with permission from the World Health Organization. This figure appears in color at www.ajtmh.org.

FIGURE 3. Geographic distribution of (A) suspected cholera cases and (B) associated deaths reported in Yemen from April 27, 2017 to January 14, 2018. This figure appears in color at www.ajtmh.org.

residing in endemic communities benefit most from vaccination either directly by the vaccine or because of herd immunity.

Yemen is considered one of the world's most water-stressed countries and Sana'a city is predicted to be the first capital city to run out of water.¹⁰ Even before the current

conflict started, almost half of the population were without sustainable access to an improved clean water supply and sanitation.¹¹ With the escalation of the civil war, the country's infrastructure, including water desalination plants and reservoirs, has been bombed to the point of collapse by several parties to the conflict and many other water systems are no

longer functioning because of severe shortages in electricity or fuel.¹² Moreover, a few areas, such as Taiz city, have been under siege since April 2015, leaving the residents with inadequate and restricted access to water, medical supplies, and food.

Operationally and logistically, despite intensive efforts by the WHO-United Nations Children's Fund (UNICEF)-led Yemen WASH cluster, the provision of safe water and sanitation to the entire population might not be achieved in the rapidly deteriorating situation in Yemen, as this goal has not been achieved in any of the previous major cholera epidemics in different countries. Thus, vaccination is an imperative intervention to protect vulnerable people until clean water and sanitation can be provided. A number of key measures are imperative to enhance the current efforts against this deadly epidemic and its potential subsequent waves as well as other further epidemics in Yemen.

1. Rollout of a cholera vaccination program as a safe, efficient, and cost-effective intervention to provide protection for 2–5 years, based on reported successes in other countries.^{13,14} Although a potential third wave of the current cholera epidemic or other further epidemics cannot be ruled out, a vaccination plan should be reconsidered to protect vulnerable Yemenis. The vaccine can be administered to those at risk and those who have not yet been infected; however, it is also preferable to vaccinate individuals who have recently been infected.
2. Continuation of the WASH program is imperative but is still insufficient and it should be extended as widely as possible and integrated with a vaccination campaign. The plan must be facilitated by the government of Yemen through the provision of protection for non-governmental organizations personnel.
3. Timely establishment of diarrhea treatment centers (DTCs) and oral rehydration points (ORPs) across the country. A total of 259 DTCs and 1,155 ORPs have been setup by the WHO so far.⁶
4. Provision of therapeutic and diagnostic supplies and fuel to health facilities is crucial to ensure the sustainability of interventions. If the shortages are not assuaged soon, there could be many more deaths because of large-scale epidemics of cholera and other diseases.
5. Community mobilization through the recruitment and training of women, youth, and social activists in targeted communities in water source chlorination, awareness-raising campaigns, infection control, and case management. This should also be integrated with the vaccination and the WASH program.
6. Endeavor to ensure that all parties to the conflict to respect medical neutrality and the sanctity of health facilities in compliance with international humanitarian law, as the collapse of the health-care system will lead to catastrophic epidemics.
7. There is a critical need for conducting research to identifying the strains of cholera isolates and their genomic characterization, modeling the determinants, and impact of interventions and control strategies against cholera throughout the country. This would contribute to better understanding of the cholera transmission dynamics and to develop an effective preparedness and response plan for potential cholera epidemics in Yemen and other countries. Moreover, large-scale evaluation of the medical, social, political, and economic aspects of cholera vaccines in such

crisis situation would help the WHO to attain the newly announced global roadmap for reducing cholera mortality by 90% by 2030.¹⁵

All current and suggested interventions require substantial funding. However, until December 2017, the UN has received only US\$1.6 billion of US\$2.3 billion requested for its response plan 2017 for Yemen.¹⁶ Despite huge support from the WHO, UNICEF, World Bank, and other international partners, Yemen's conflict-induced deterioration is expected to worsen. Thus, more efforts are urgently needed to save the lives of millions of people in war-torn Yemen.

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