

Perspective Piece

Mitigating Cholera in the Aftermath of Cyclone Idai

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Abstract. Catastrophic damage and floods followed the deadliest cyclone on record for the Southern Hemisphere. In the aftermath of Cyclone Idai, a cholera outbreak was detected. The global stockpile of oral cholera vaccine was rapidly deployed to counter this fast-growing epidemic. We urge the international community to continue to highlight the importance of water, sanitation, and hygiene as the long-term goal for controlling cholera and meeting the 2030 Sustainable Development Goals.

Cyclone Idai is recognized as one of the deadliest cyclones on record for the Southern Hemisphere.¹ Beginning as a tropical depression around March 4, 2019, Cyclone Idai struck the southeastern coast of Africa at Beira, Mozambique, the night of 14 March. For a week, heavy rains and wind battered the area; first with the tropical depression, intensifying as the system grew to a cyclone, and slowly dissipating as the system weakened and moved off the coast—ending by 21 March. As a result, massive flooding was observed in Mozambique, Malawi, and Zimbabwe. NASA satellite imaging estimates that some areas experienced up to 50 cm (20 inches) of rain.²

The effects of the storm are staggering. Damages amount to estimates in the range of \$1 billion to infrastructure.³ As many as 3 million people may have been affected, with two-thirds in Mozambique, predominantly in the areas surrounding the port city Beira.⁴ The United Nations Office for the Coordination of Humanitarian Affairs estimates that in Mozambique, 500,000 hectares were flooded, destroying crops just before the annual harvest and killing livestock.⁵ This occurred after recent significant improvements to stormwater drainage management; the Mozambique Cities and Climate Change Project represented a US\$120 million investment beginning in 2012 from the World Bank.⁶ Clearly, no amount of municipal planning could have avoided Cyclone Idai's devastating effects.

In the hardest-hit coastal region of Mozambique, five acute diarrheal disease cases were first reported on 27 March, cholera was confirmed, and cholera cases quickly escalated thereafter. Within approximately a week, 1,428 suspected cholera cases were reported. The Mozambican Ministry of Health in partnership with the WHO rapidly applied for oral cholera vaccine (OCV) from the Gavi-supported emergency stockpile, with vaccines arriving in country on 2 April. On the very next day, the ministry and partners kicked off a 6-day campaign, targeting 885,000 people in Beira.⁷

The conditions for a cholera outbreak in Northern Mozambique should be no surprise. This cyclone hit an area where cholera is highly endemic and has been well documented since at least the 1990s.^{8,9} Molecular analyses of *Vibrio cholerae* isolates from Mozambique have shown them to be highly diverse within the country, often distinct from other parts of southern Africa with evidence of some *V. cholerae*

sub-lineages circulating for close to a decade.^{10–12} On top of this disease landscape is the dismal water and sanitation situation, where only 47% of the country has at least basic drinking water access, 14% rely on untreated surface water for drinking, and only 24% have access to at least basic sanitation infrastructure.¹³

The most sustainable means for controlling cholera is the provision of safe drinking water, systems to treat waste, and general observance of hygiene.¹⁴ Municipally sourced, centralized water treatment and distribution require infrastructure and long-term financial and political willpower. Nonetheless, even when available, well-established and functional infrastructure for this water is at risk during times of war or when natural disasters occur. Similarly, the treatment of human feces and maintaining it segregated from clean water are also a form of infrastructure that is at risk during war and disasters.

Shortly after the earthquake in Haiti in 2010, the large, internally displaced, and immunologically naive population was exposed to raw sewage contamination of their primary drinking water source, the Artibonite River.¹⁵ Subsequently, cholera became endemic to Haiti with close to 1.3 million cases to date. Fortunately, cholera case reports have declined in the past year, with the annual incidence in 2018 being just 1% of the annual incidence in 2011, and less than 200 cases have been reported by mid-2019.^{16,17} Although large efforts at improving water and sanitation have been made,¹⁸ it is unclear whether these reductions in cases are due to reductions in these structural risk factors, reductions in cholera-susceptible individuals (due to immunity from natural infection and vaccination),¹⁹ or a mix of both. The ongoing civil war in Yemen since 2015 has resulted in chronic water scarcity, damaged and nonfunctional sanitation services, an overburdened and severely limited health system, and a large internally displaced population. The ongoing Yemen cholera outbreak, which began in October 2016, is considered the largest outbreak ever recorded.²⁰ Without an end to the conflict in Yemen, safe water and sanitation will continue to be lacking and cholera will be problematic, as evidenced by the recent surge in reported cases.²¹ Given the state of safe water, sanitation, and hygiene (WASH) infrastructure before the cyclone, WASH improvements sufficient to halt cholera transmission are unlikely in the immediate term and other risk reduction interventions are needed in the interim.

The use of OCVs is recommended in addition to WASH and as a complimentary public health intervention for settings with endemic cholera, for areas at risk for cholera outbreaks, and

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for the control of cholera outbreaks. There are presently three WHO prequalified OCVs available, among which two are stockpiled through support from Gavi.²² This global stockpile was initially established in 2013 and its use is coordinated by an International Coordinating Group (ICG), composed of experts from Médecins sans Frontières, the International Federation of the Red Cross and Red Crescent Societies, the United Nations Children's Fund, and the WHO.²³ During 2018, there were 11 deployments of stockpiled OCV, delivering 6,323,410 doses to Malawi, Bangladesh, Nigeria, South Sudan, Lao People's Democratic Republic, Zimbabwe, and Niger.^{24,25}

Two doses of the presently available killed whole-cell OCVs taken approximately two weeks apart have demonstrated 53–69% protection among adults for at least 3 years; however, the protective efficacy is diminished among young children.^{26–30} Because of the logistical burden of completing two spaced doses in large and highly mobile populations living under desperate conditions, a single dose of OCV was evaluated in a cholera-endemic setting and demonstrated at least two years of sustained protection (52%) for older children (≥ 5 year old) and adults although children younger than 5 years did not appear to be protected, even in the first 6 months.^{31,32} Nonetheless, when a single dose of the OCV is deployed reactively, as a control measure during a cholera outbreak, the effectiveness has been observed to be around 87–89%.^{33,34} Similarly, a single dose of live OCV (CVD 103-HgR, not currently available globally), used in a reactive vaccination campaign in Micronesia, demonstrated 79% efficacy.³⁵ When the two spaced doses were administered in a mass vaccination campaign in Beira, Mozambique in 2003–2004, there was 84% protection, including 82% protection among young children (< 5 years).⁹ As vaccines are presently limited globally, with a fixed amount of vaccines, use of a single-dose strategy may prevent more total cases and deaths than the standard two-dose regimen.³⁶ Therefore, OCVs have become a powerful tool toward the immediate term goal of controlling cholera.

On April 10, 2019, the Ministry of Health, Mozambique, concluded their 6-day cholera vaccination campaign, reaching > 800,000 people in four districts (Beira, Dondo, Nhamatanda, and Buzi) and reporting high uptake and good public perception by the local communities.³⁷ Although Mozambique, WHO, the ICG, and Gavi should be applauded for this rapid deployment of OCV, it is still too early to claim success. Over the coming months and years, the international community must help Mozambique develop its WASH infrastructure while mitigating the effects of Cyclone Idai by reestablishing land and sea transportation and trade routes, tackling food insecurity, and the rebuilding of homes.

At the 71st World Health Assembly, 10 countries, including Mozambique, helped to draft a successful resolution urging Member States and the Director General to act on cholera prevention and urging cholera-affected countries to implement a road map to reduce deaths from the cholera by 90% by 2030.³⁸ As countries in the region, like Mozambique's neighbor Malawi, have started to develop long-term plans for cholera control, outbreaks like this either can distract from these long-term goals or be a catalyst for change. We urge the international community to team with Mozambique and the surrounding region to use this as a catalyst for change and

encourage the substantial investments needed to make progress on the development of WASH and the overall long-term control of cholera.

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