# Article Three

## Integrated public health response to the 2025 cholera outbreak in Northern Province, Zambia: implementation, early outcomes, and lessons.

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## Abstract

**Background:** Cholera remains a recurring public health emergency in Zambia, particularly in lakeshore and border districts, where inadequate water, sanitation, and hygiene (WASH) infrastructure increases the risk of transmission. In August 2025, an outbreak that started in Mpulungu District spread to Nsama and Mbala, triggering the activation of Zambia's integrated outbreak response frameworks. This paper outlines the outbreak's epidemiological progression and evaluates implementation, challenges, and lessons learned from the integrated multi-pillar response in these high-risk, hard-to-reach settings.

**Methods:** We conducted a descriptive analysis of the response from August 5 to September 24, 2025, using surveillance line lists, laboratory registers, situation reports, and partner activity records. The analysis focused on how the 7-1-7 framework, Incident Management System (IMS), Case Area Targeted Interventions (CATI), risk communication and community engagement (RCCE), WASH/IPC measures, and Oral Cholera Vaccination (OCV) preparedness were operationalized within a multi-pillar coordination structure.

**Results:** By September 24, 2025, there were 239 cholera cases and two deaths (case fatality rate of 0.8%) reported across the three districts. Early detection and quick IMS activation met the 7-1-7 timeliness targets. CATI allowed rapid containment of emerging clusters through household disinfection and contact tracing, while WASH and RCCE efforts reached over 58,000 people. Preparatory OCV micro-planning was completed in Mpulungu and Nsama

However, implementation faced several challenges, including transport and fuel shortages, limited trained personnel, weak real-time data systems, and a shortage of multilingual RCCE materials in remote areas.

**Conclusions:** The 2025 outbreak demonstrated the effectiveness of Zambia's integrated, multi-pillar cholera response. Enhancing decentralized rapid-response capabilities, investing in digital surveillance and multilingual communication, and improving cross-border coordination for CATI and OCV campaigns will be essential to maintain progress toward cholera elimination.

**Keywords:** Cholera, Zambia, Outbreak response, WASH, 7-1-7 Framework, Case Area Targeted Interventions, Oral Cholera Vaccination.

## Introduction

Cholera remains a major global public health threat, with an estimated 1.3–4.0 million cases and 21,000–143,000 deaths each year (1). Although largely preventable through proper water, sanitation, and hygiene

(WASH), ongoing transmission reflects underlying social inequalities. Systematic reviews indicate that WASH factors have a strong influence on cholera risk and that properly implemented WASH measures effectively reduce transmission (2,3). In sub-Saharan Africa, recurrent outbreaks are persistent and predictable, with high-risk areas marked by weak WASH infrastructure and rapid, often unplanned urban growth. (4,5). Furthermore, hydro-climatic factors, including floods and droughts, influence seasonal patterns and increase risk (6,7). Additionally, cross-border movement of populations further spreads the disease and complicates control efforts along international routes (8). These combined factors strain health systems and delay effective responses, even when technical guidance exists (5,6).

In August 2025, the Africa CDC and WHO launched the Continental Cholera Response Plan (9) during an event in Lusaka, Zambia. Driven by the African Union (AU) and championed by President Hakainde Hichilema, this initiative seeks to eradicate cholera across Africa by 2030. It focuses on coordinated surveillance, swift response, broader vaccination efforts, and improved WASH systems. The plan will be implemented by a joint Incident Management Support Team (IMST) and signifies a renewed continental commitment to unified, cross-border strategies aimed at eliminating cholera.

Zambia has experienced cholera outbreaks since the late 1970s, with the first documented epidemic recorded in 1977 (10). Large-scale epidemics have recurred periodically, often affecting densely populated peri-urban settlements in Lusaka and the Copperbelt (Hosea et al., 2008; Zambia's Battle Against Cholera, 2023).

In recent decades, more than 30 outbreaks have been documented nationwide (11). Particularly, lakeshore and border districts such as Mpulungu, Nsama, and Mbala are increasingly recognized as high-risk zones due to long-standing deficits in safe water supply, reliance on unprotected water sources, and cross-border population movement associated with fishing, trade, and seasonal migration (12,13). These ecological, infrastructural, and mobility-related risk factors create favourable conditions for both the introduction of Vibrio cholerae and sustained local transmission.

To respond to cholera outbreaks in Zambia's most vulnerable districts, the Zambia National Public Health Institute, whose mandate is to safeguard public health security, adopts globally endorsed response frameworks that Rapid Response Teams (RRT) utilize, namely: the 7-1-7 target for outbreak response timeliness (disease detection within seven days of occurrence, notification or reporting within a day, and response with seven days of notification) (14); Incident Management Systems (IMS) to organize coordination; Case Area Targeted Interventions (CATI) for targeted cluster containment (15); and Oral Cholera Vaccination (OCV) to reduce community susceptibility. These strategies are complemented by surveillance, WASH as part of Infection Prevention and Control (IPC), case management, and risk communication and community engagement (RCCE). However, there is a scarcity of detailed descriptions of how these frameworks work together in remote lakeshore and border areas. The 2025 cholera outbreak in Zambia presents a critical opportunity to document early lessons from Zambia's response in hard-to-reach settings.

On August 5, 2025, a Tanzanian national presented at Chipwa Rural Health Centre in Mpulungu with severe watery diarrhea. Rapid diagnostic testing confirmed the presence of cholera, and epidemiological tracing linked the index case to a cross-border movement along Lake Tanganyika. By late September, the transmission had spread to Nsama, Mbala, and Senga Hill districts, necessitating a multi-level deployment of interventions. This study, therefore, aims to: (1) outline the outbreak's epidemiological progression and (2) evaluate implementation, challenges, and lessons learned from the integrated multi-pillar response in these high-risk, hard-to-reach settings.

## Methods

### Study design and setting

This descriptive programmatic analysis examined Zambia's integrated cholera response to the 2025 outbreak in Mpulungu, Nsama, and Mbala districts of the Northern Province. These districts, situated along the southern shores of Lake Tanganyika, represent a high-risk cholera corridor characterized by fishing activities, unprotected water sources, limited sanitation infrastructure, and frequent cross-border population movement with Tanzania. The analysis covered August 5–September 24, 2025, from the index cholera case detection to the latest consolidated situation report (latest consolidated situation report).

### Data sources and integration

The study utilized routine programmatic data collected during the 2025 cholera outbreak response in Zambia's Northern Province. We extracted key epidemiological information from daily case line lists and laboratory reg-

isters. Additionally, reports from essential pillars such as surveillance, RCCE, WASH, case management, and OCV provided operational insights into interventions that contributed to this paper. Moreover, situation reports delivered consolidated analyses and updates on the response. These quantitative data and debriefs with district health teams, rapid response teams (RRTs), and community-based volunteers (CBVs) were supplemented with qualitative insights from after-action reviews, enriching the evaluation with field experiences and lessons learned.

## Conceptual and analytical frameworks

The overall response was broadly structured under two governance frameworks: the 7-1-7 epidemic timeliness target (14,16) and the IMS, an operational delivery model driven by the CATI framework (15). Below, we highlight the response models and structures that characterised ZNPHI and MoH's response to the 2025 cholera outbreak in Northern province.

## Governance and coordination frameworks

The 7-1-7 target set a performance benchmark for timeliness, aiming to identify the outbreak within seven days of emergence, notify and investigate within one day, and execute an effective multisectoral response within the following seven days. The IMS maintained structured coordination among district, provincial, and national levels, guiding resource mobilization, partner collaboration, and the flow of reporting. Daily IMS meetings at the district level synchronized technical activities and informed provincial and national decision-making.

## CATI as the operational delivery model

The CATI approach served as the core framework guiding the integrated outbreak response. Once a suspected or confirmed cholera case was identified, response teams rapidly deployed a coordinated package within a defined radius of about 20–30 households (100–150 people). This included active case finding and contact tracing, rapid WASH and IPC measures such as household and water source disinfection, immediate case management through referrals and oral rehydration points, and targeted RCCE activities on hygiene and care-seeking. Delivering these interventions within 24–48 hours ensured that surveillance, case management, WASH/IPC, and RCCE were implemented synergistically to contain transmission quickly and effectively.

## Technical pillars implemented through CATI

Within the CATI framework, we deployed all technical pillars in a coordinated and targeted manner to strengthen outbreak control. We enhanced surveillance and laboratory diagnostics by line-listing every suspected case, conducting rapid diagnostic tests and confirmatory cultures, and transmitting daily updates through the electronic IDSR platform. We strengthened case management by establishing cholera treatment centres in Mpulungu Urban and Chipwa, setting up oral rehydration points in high-incidence areas, training clinicians on WHO treatment protocols, and pre-positioning essential supplies such as IV fluids, antibiotics, and oral rehydration salts.

We implemented WASH and IPC interventions that included household chlorination, water-source disinfection, installation of latrines and handwashing stations, and safe burial practices to reduce environmental transmission risks. We intensified RCCE efforts through door-to-door sensitization, radio and public announcements of key messages, and engagement with traditional and faith leaders to improve community awareness and promote early care-seeking behavior. Finally, we advanced OCV preparedness by completing detailed microplanning and cold-chain assessments, in close collaboration with WHO and UNICEF, to ensure readiness for vaccine deployment once doses became available. Through these combined efforts, we ensured that each technical pillar directly contributed to rapid containment and the integrated delivery of interventions at the community level.

## Data management and analysis

We established a structured, multi-tiered data management system to provide timely, accurate, and actionable information during the outbreak response. Quantitative data were mainly gathered through the electronic Integrated Disease Surveillance and Response (eIDSR) platform, which served as the primary reporting system for daily case notifications from health facilities. District IMS teams compiled and verified this data before submitting it to the provincial IMS for consolidation. The eIDSR dashboard was then used to produce real-time epidemiological outputs, including epidemic curves, trend tables, and geographic distribution summaries, supporting rapid decision-making and resource allocation.

To enhance routine surveillance, field teams used Kobo Collect to map transmission clusters and visualize spatial trends through epidemiological maps (epi-maps), improving the geographic accuracy of interventions. Additionally, community-based volunteers (CBVs) gathered qualitative data through debriefs and field

reports, offering valuable insights into community behaviors, perceptions, and barriers to intervention uptake. These qualitative findings were combined with quantitative surveillance data to improve interpretation and support adaptive response strategies. This integrated data system, integrating real-time reporting, geospatial mapping, and field-level intelligence, provided a comprehensive understanding of outbreak dynamics and supported evidence-based decision-making at all levels of the response.

### Ethical considerations

This analysis was based on routine programmatic data collected during a public health emergency. It was covered by the umbrella protocol of the Field Epidemiology Training Program that was approved by the Zambian National Health Research Authority (NHRA) in 2023.

## Results

### Epidemiological overview

From August 5 to September 23, 2025, a total of 239 cholera cases and two deaths (case fatality rate = 0.8%) were reported across Mpulungu, Nsama, and Mbala Districts. Figure 1 shows an early peak in mid-August, corresponding to increased community transmission in lakeshore fishing camps and peri-urban Mpulungu.

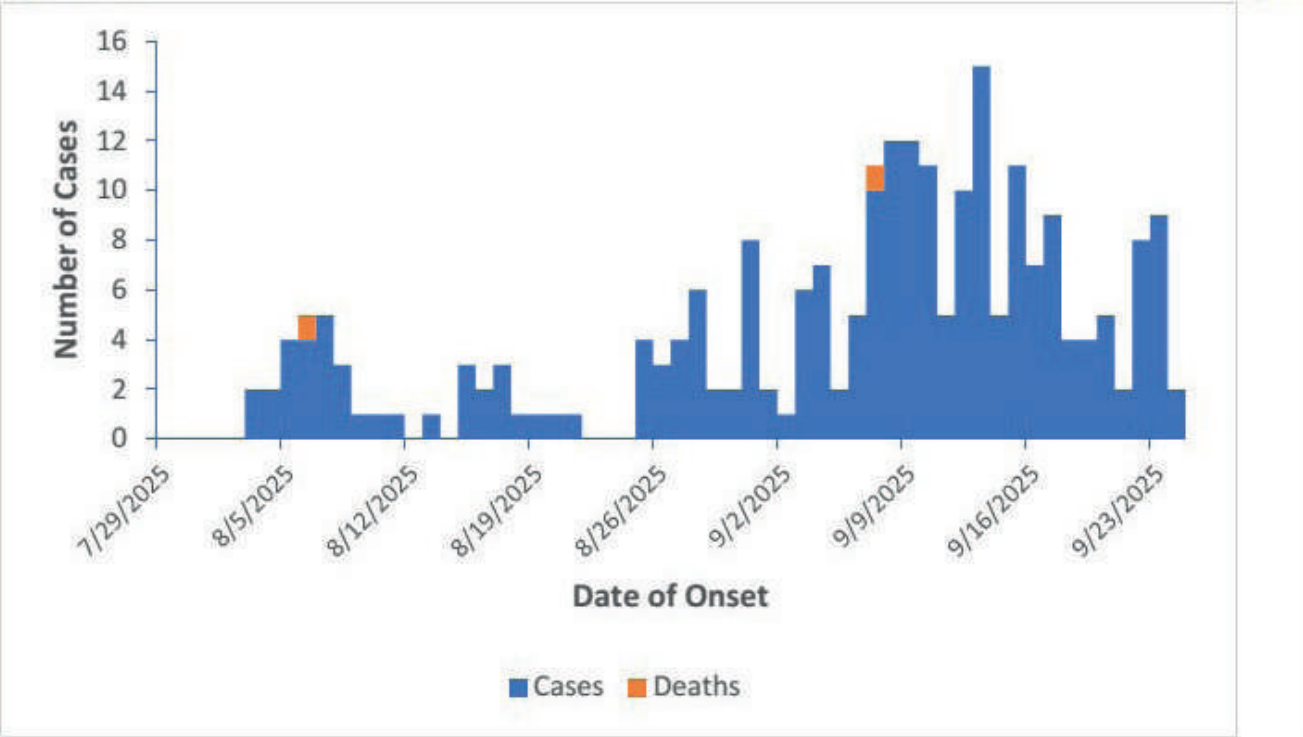


*Figure 1: Epidemiological characteristics of the 2025 cholera outbreak in Northern Province, Zambia (5 August–23 September 2025). Note: the date format is m/d/y.*

Furthermore, the spatial distribution in Mpulungu District indicated strong clustering along the Lake Tanganyika corridor, suggestive of an association of cross-border and fish trade movements with cholera spread, particularly in Mpulungu. Figure 2 illustrates a map of the cholera case distribution in Mpulungu along the Tanganyika lakeshore.

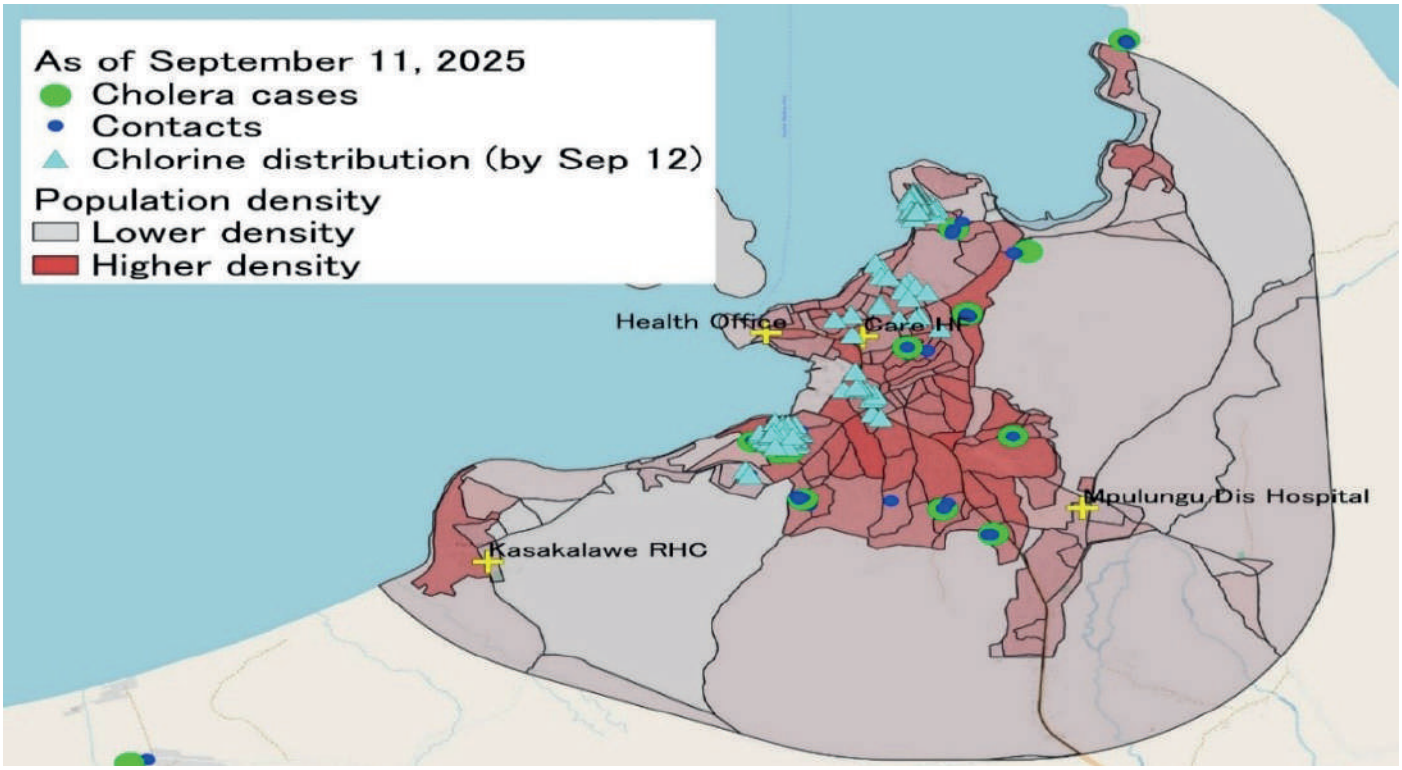


*Figure 2: Map of the cholera case distribution in Mpulungu along the Tanganyika lakeshore*

## Timeliness of detection and response (7-1-7 Framework)

Detection and notification occurred within 48 hours of the index case, and an integrated response was operational within five days, meeting the 7-1-7 benchmark. Overall, Figure 3 shows the evaluation of the 7-1-7 response framework's successful implementation and some of the bottlenecks experienced during ZNPHI and MoH's rapid response in Mpulungu. Prompt initiation of surveillance, case management, and WASH interventions helped control early transmission of the disease. However, expanding efforts to remote fishing camps revealed logistical challenges, including delays in RRT deployment due to poor road access and fuel shortages, as well as communication gaps that affected data flow from peripheral facilities.

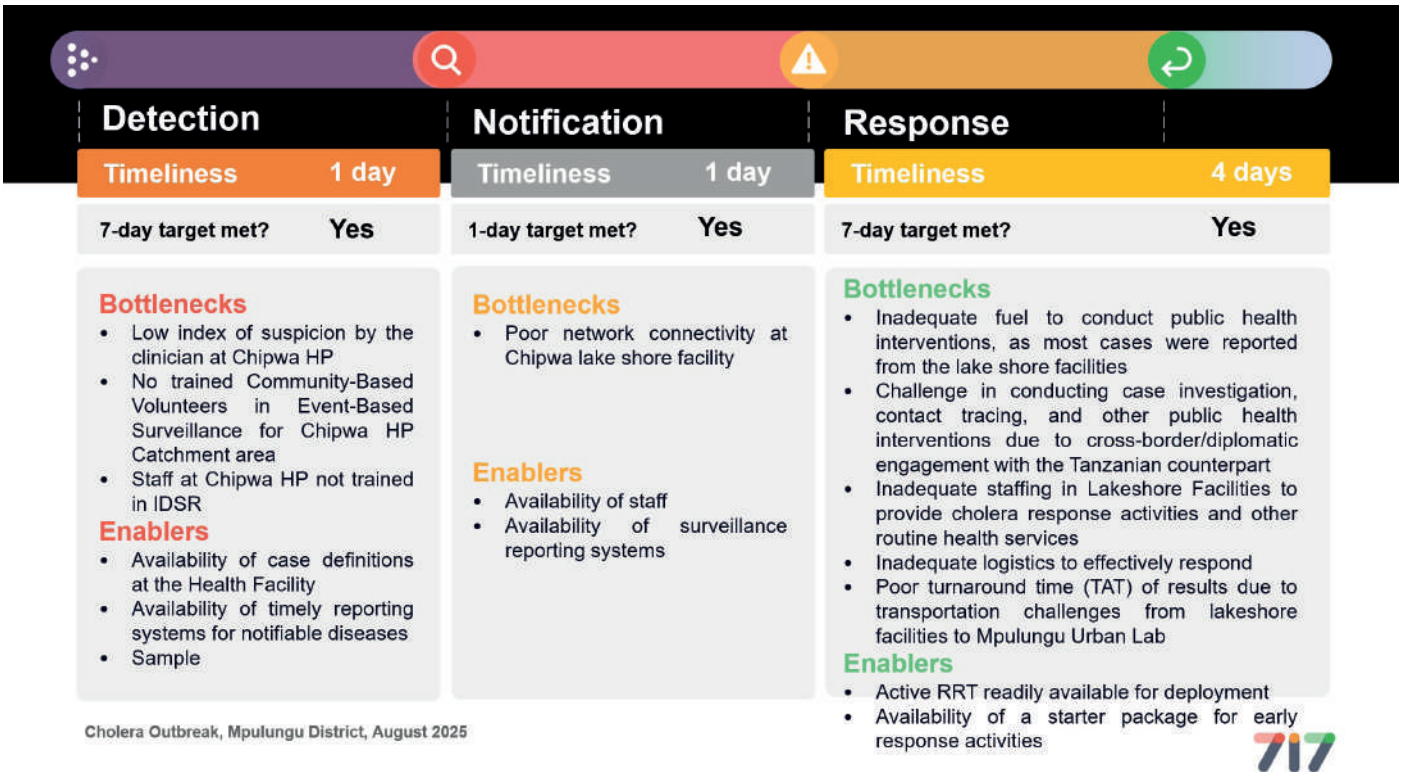


*Figure 3: The 7-1-7 Framework implementation during the rapid response to the cholera outbreak in Mpulungu, Northern Province, in August 2025.*

## Coordination and multi-level governance through the IMS

The IMS facilitated coordination across district, provincial, and national levels. Daily district IMS meetings synchronized activities among technical pillars, while the provincial IMS provided surge staffing and laboratory oversight. The national IMS supported partner alignment and resource mobilization. However, staff turnover, delayed financial disbursements, and limited transport capacity hindered the simultaneous deployment of CATI across multiple hotspots. Figure 4 illustrates the organization of technical response pillars using the CATI operational framework, which is coordinated through district, provincial, and national IMS to ensure multi-sectoral integration and a timely response.

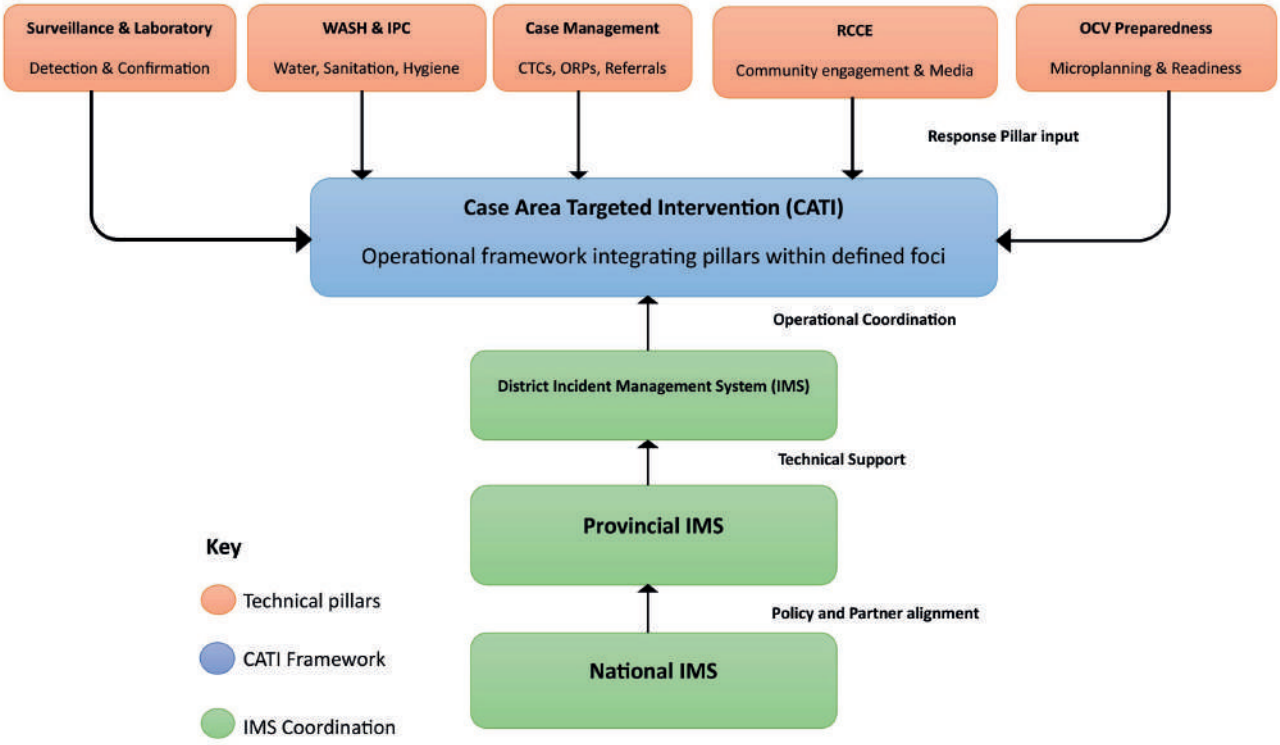


*Figure 4: Integrated coordination and delivery structure for cholera outbreak response in Northern Province, Zambia, 2025*

## Implementation of CATI as the operational framework

CATI functioned as the central operational delivery model, integrating surveillance, WASH/IPC, case management, RCCE, and OCV readiness within specified outbreak zones. Response teams reached affected households within 24-48 hours of case confirmation, performing contact tracing, household disinfection, and point-of-use chlorination. Table 1 highlights key CATI performance indicators. CATI quickly contained clusters in Mpulungu Urban but was less consistent in some lakeshore areas within Mpulungu, Nsama, and Mbala, where terrain and transportation issues slowed down geographic coverage.

*Table 1: Implementation performance of Case Area Targeted Interventions (CATI) for cholera in Northern Province from August to September 2025*

| District | Clusters investigated | Median time to response (hrs) | Households disinfected | Clusters contained within 14 days (%) |
|---|---|---|---|---|
| Mpulungu | 17 | 8 | 231 | 88.2 |
| Nsama | 9 | 10 | 146 | 77.8 |
| Mbala | 6 | 12 | 88 | 66.7 |

## Surveillance and laboratory findings

Enhanced surveillance improved case detection and timeliness of reporting. Health facilities conducted RDT screening and stool culture confirmation at the provincial level, while community-based volunteers facilitated active case finding and contact follow-up. As summarized in Table 1, daily reporting through the eIDSR platform enhanced data completeness, although weak internet connectivity in lakeshore health posts led to under-reporting and occasional backlogs.

## Case management outcomes

Some CTCs and multiple ORPs were strategically set up across the affected districts. Clinical management was conducted in accordance with WHO guidelines, supported by refresher training and partner-provided emergency kits. The overall CFR stayed below 1%, indicating effective early treatment. However, limited inpatient capacity in rural facilities and delayed referrals during heavy rains hindered the speed of care escalation.

## WASH and IPC interventions

District WASH teams carried out household chlorination, disinfected latrines, and installed temporary handwashing stations at schools and markets, as shown in Table 2. Burial teams were trained and deployed to conduct safe and respectful burials. Although there was extensive coverage in Mpulungu, shortages of chlorine supply and difficult terrain limited the consistency of interventions in lakeshore communities.

*Table 2: Summary of Water, Sanitation and Hygiene (WASH) and Infection Prevention and Control (IPC) interventions implemented during the 2025 cholera outbreak, Northern Province, Zambia*

| Intervention | Indicator | Total achieved | Remarks |
|---|---|---|---|
| Water safety | Public water points chlorinated | 85 | ≥0.5 mg/L* residual chlorine maintained |
| Sanitation | Temporary latrines installed | 42 | Focused on fishing camps |
| Hygiene promotion | Handwashing stations established | 57 | Schools and markets targeted |

*mg/l - Milligrams per litre

## RCCE activities

RCCE interventions reached a wide community audience by utilizing schools, churches, and markets as channels for messaging, particularly through door-to-door campaigns and mass media spots, which reached only 6,297 people as per Table 3. Ongoing Information, Education, and Communication (IEC) material shortages, limited translation into local languages, and inadequate CBV coverage in remote areas reduced the message's reach in some communities.

*Table 3: Reach and coverage of risk communication and community engagement (RCCE) interventions during the 2025 cholera outbreak, Northern Province, Zambia*

| District | Target population | Population reached | Proportion reached (%) | Key notes |
|---|---|---|---|---|
| Mpulungu | 73,838 | 4,686 | 6.3 | High engagement in Chipwa; urban areas lagged |
| Nsama | 66,404 | 1,006 | 1.5 | Focus on schools and markets |
| Mbala | 44,119 | 605 | 1.4 | Limited reach due to staffing constraints-few CBVs* |

*Note: The target population is based on district health promotion estimates.*

**CBVs – Community-based Volunteers*

## OCV preparedness

By late September, OCV microplanning and cold-chain readiness assessments were completed in all the focus districts. Table 4 shows the OCV preparedness status of each district as of 24th September 2025. Engagement with traditional leaders fostered strong community receptivity to vaccination. However, deployment was delayed due to global vaccine shortages and logistical challenges in reaching mobile populations on the lakeshore.

*Table 4: Oral cholera vaccination (OCV) campaign preparedness status as of 24 September 2025, Northern Province, Zambia*

| District | Target population | Microplanning status | Vaccine deployment status |
|---|---|---|---|
| Mpulungu | 73,838 | Completed | Completed |
| Nsama | 66,404 | In progress | Not initiated |
| Mbala | 44,119 | In progress | Not initiated |

## Discussion

This study provides a systematic assessment of Zambia's early response to the 2025 cholera outbreak in Mpulungu, Nsama, and Mbala Districts, focusing on both implementation fidelity and contextual challenges. By examining the response through the combined perspectives of 7-1-7, IMS coordination, and CATI delivery, we demonstrate how global frameworks were adapted to a difficult lakeshore environment, and we identify key bottlenecks that limit their effectiveness.

Detection of the index case within 48 hours and initiation of an integrated response within a week show that the 7-1-7 timeliness benchmark is achievable, even in resource-limited districts. Similar quick responses in outbreak settings have been associated with lower transmission and mortality rates (17). However, maintaining that early response in remote lakeshore areas was inconsistent, as logistical issues delayed team deployment to new clusters. This pattern reflects the challenges faced in low-resource settings that hinder cross-cluster mobilization (15).

IMS coordination served as the backbone of the mul-

ti-pillar response. Daily district-level meetings facilitated rapid decision-making, while provincial and national tiers provided technical surge support and resource coordination. This structure aligns with emergency management best practices, wherein public health IMS platforms or emergency operations centers (EOCs) are established to centralize command and coordination (18,19). However, persistent challenges, including high staff turnover, delays in funding disbursement, and weak transportation logistics, constrained the IMS's ability to scale CATI across multiple hotspots, particularly in remote areas. These limitations were also observed in broader health system coordination studies (20,21).

Implementing CATI as our operational delivery strategy enabled the integrated deployment of surveillance, WASH/IPC, case management, and RCCE in defined outbreak zones. In Mpulungu's early clusters, CATI appears to have rapidly curtailed transmission, consistent with evidence showing that prompt, repeated CATIs can shorten outbreak duration and reduce clustering (22,23). However, in Nsama and Mbala, terrain constraints, fuel shortages, and transport deficits limited reach, a pattern mirrored in other settings where CATI effectiveness was conditional on sufficient logistical and surge capacity (23,24).

Surveillance and laboratory diagnostics were fundamental to the response, enabling case confirmation and hotspot mapping. However, delays in real-time data entry and weak connectivity at lakeshore health posts hindered prompt situational awareness. Outbreak response literature increasingly highlights the importance of digital surveillance systems, offline-capable tools, and integrated feedback loops (25). Investing in resilient digital platforms would improve operational agility in geographically limited settings.

The observed case fatality rate (CFR) below 1% aligns with benchmarks for quality cholera case management and demonstrates the impact of early treatment, rapid setup of cholera treatment centres (CTCs), and supply pre-positioning (26). Nevertheless, in remote settings such as the Northern province of Zambia, limited inpatient capacity and delays in referrals due to poor road conditions or inaccessibility due to large water bodies reveal persistent inequities in access to lifesaving care.

WASH and IPC interventions, including chlorination, latrine installation, and water-source disinfection, are well-supported by the literature as essential components for outbreak containment (27,28). However, as observed in our response, interruptions caused by IPC commodity stockouts and the difficulty of reaching dispersed fishing communities curtailed consistent coverage.

Furthermore, RCCE played a pivotal role in improving public awareness and encouraging protective behaviors during the outbreak. Institutional outreach through schools, churches, markets, and other social platforms proved highly effective in amplifying prevention messages and fostering trust between communities and responders, a factor consistently linked to higher compliance with health measures during epidemics (29,30).

Coordination through the IMS ensured message consistency, minimizing misinformation and reinforcing public confidence. However, limited translation of IEC materials, inadequate supply chains, and understaffed networks of community-based volunteers constrained message penetration in remote, multilingual settings. Evidence from previous cholera and Ebola responses shows that pre-positioned multilingual RCCE kits, coupled with expanded, locally trained volunteer networks, substantially improve message reach and equity in hard-to-access populations (15,29).

OCV microplanning and cold-chain readiness were successfully implemented in Mpulungu before rollout, reflecting strong local preparation capacity. However, the actual deployment faced delays due to supply constraints and logistical challenges, a pattern documented in several post-licensure OCV analyses (31). Moreover, modeling studies in Africa show that geographic targeting of OCV campaigns can enhance cost-effectiveness and impact (32). In settings with cross-border, mobile populations, coordinated, synchronized campaigns across borders may help reduce reintroduction risk and bolster immunization efficiency, aligning with lessons from urban, targeted OCV efforts (33).

Across all pillars, persistent shortages of human resources, transport, fuel, and RCCE materials consistently hindered full implementation. These operational barriers are not unique to Zambia; evidence from other cholera responses shows that logistics, coordination, and supply chain reliability often determine the ultimate effectiveness of outbreak control efforts, rather than the technical soundness of interventions themselves (17,25,34).

## Strengths and Limitations

This study's main strength is its integration of pro-

grammatic data from multiple response pillars, offering a comprehensive and practical view of how Zambia's 7-1-7, IMS, and CATI frameworks operated during a real-world outbreak. Unlike evaluations that focus on a single pillar, it examines coordination, implementation fidelity, and early outcomes within a unified analytical perspective. Using routinely collected surveillance and operational data increases the study's relevance for health system planning and policy adaptation, as it bases its conclusions on actual field observations rather than theoretical assumptions.

However, the analysis is limited by reliance on secondary programmatic data, which may underestimate unreported cases or activities in remote areas. Data completeness varied across districts due to connectivity issues and differing reporting capacities. Additionally, the short observation window, which covers only the initial outbreak phase, restricts the ability to assess long-term outcomes, such as sustained transmission interruption or post-OCV impact.

Despite these limitations, the findings provide credible early evidence on the feasibility and effectiveness of integrated outbreak response frameworks in resource-limited, cross-border settings, offering actionable insights for future epidemic preparedness in Zambia and similar contexts.

## Conclusion and Recommendations

The early stages of the 2025 cholera outbreak in Mpulungu, Nsama, and Mbala districts of the Northern province in Zambia demonstrated both the strengths and the limitations of Zambia's epidemic response system. Furthermore, the coordinated use of the 7-1-7 framework, the IMS, and the CATI model allowed for rapid detection of cases, timely deployment of interventions, and effective case management. These efforts contributed to a low case fatality rate of 0.8 percent, showing that existing response mechanisms can significantly reduce transmission and mortality even in hard-to-reach areas.

However, key operational challenges limited the scale and effectiveness of the response. Transport and fuel shortages, insufficient human resources, and weak data systems reduced the ability to deploy interventions simultaneously in multiple locations. Limited translation and distribution of communication materials further constrained community engagement. Based on our findings, we recommend that the Ministry of Health and its partners strengthen response capacity at the district level through pre-positioned supplies, trained mobile teams, and reliable surge funding to improve future operations. Additionally, ZNPHI should support the upgrade of digital surveillance tools, including offline-capable systems, to allow faster data reporting and analysis through the eIDSR. Furthermore, we recommend expanding CBV networks, training on multi-hazards, and ensuring multilingual communication materials are prepared in advance to improve the reach and quality of engagement.

Lastly, our results showed that cross-border coordination is essential to prevent future cholera outbreaks. Therefore, we recommend that the Ministry of Health and ZNPHI, in collaboration with partners such as UNICEF, the International Federation of Red Cross, the WHO, and the Africa CDC, should align surveillance, targeted interventions, and oral cholera vaccination campaigns with neighboring countries along the Lake Tanganyika corridor to enhance control efforts in line with the International Health Regulations (IHR). We are convinced that implementing these recommendations, drawn from the lessons of the 2025 outbreak, will strengthen Zambia's preparedness and accelerate progress toward national and continental cholera elimination targets.

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