

CHOLERA IN YEMEN:  
A CASE STUDY OF EPIDEMIC  
PREPAREDNESS AND RESPONSE



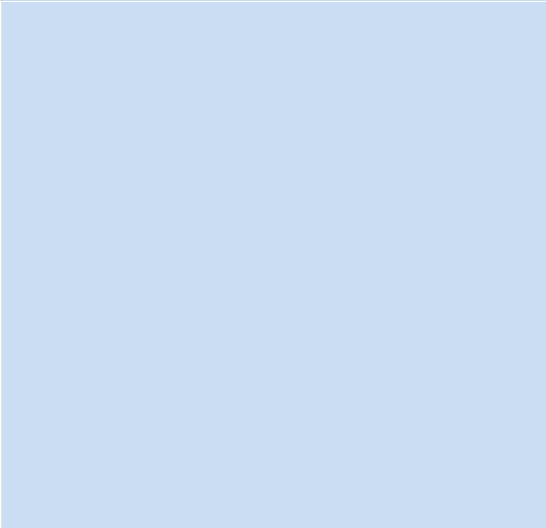
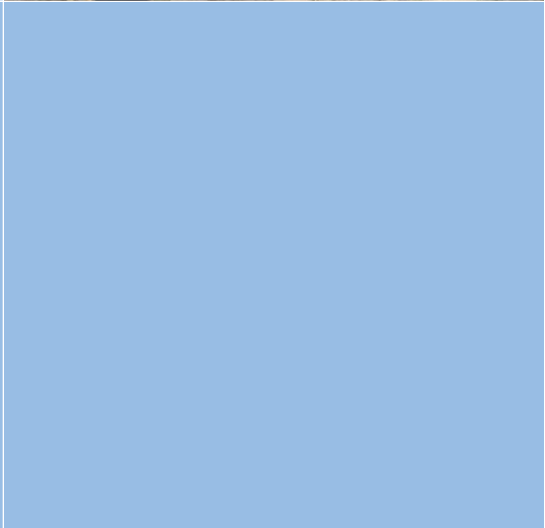
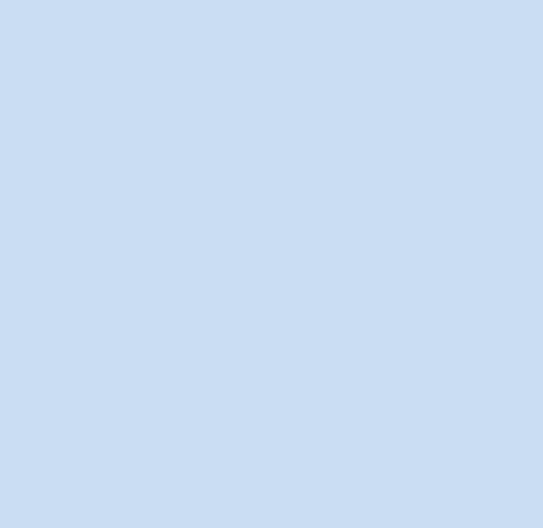
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# CHOLERA IN YEMEN: A CASE STUDY OF EPIDEMIC PREPAREDNESS AND RESPONSE

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# ACRONYMS

ACF	Action Contre la Faim
AR	Attack Rate
C4	Cholera Command and Control Center
C4D	Communication for Development
CDC	Centers for Disease Control and Prevention
CFR	Case Fatality Ratio
CHV	Community Health Volunteer
CHW	Community Health Worker
CIVIC	Center for Civilians in Conflict
CTC	Cholera Treatment Center
CTF	Cholera Task Force
CTU	Cholera Treatment Unit
DFID	Department for International Development
DTC	Diarrhea Treatment Center
ECHO	European Civil Protection and Humanitarian Aid Operations
eDEWS	Electronic Disease Early Warning System
EMRO	World Health Organization Regional Office for the Eastern Mediterranean
EOC	Emergency Operations Center
ERF	Emergency Response Framework
EVD	Ebola Virus Disease
EWARS	Early Warning Alert and Response System
FRC	Free Residual Chlorine
GAM	Global Acute Malnutrition
GARWSP	General Authority for Rural Water Supply Projects
GHC	Global Health Cluster
GNC	Global Nutrition Cluster
GOARN	Global Outbreak Alert and Response Network
GTFFC	Global Task Force for Cholera Control
GWC	Global Water, Sanitation and Hygiene (WASH) Cluster
IASC	Inter-Agency Standing Committee
iCCM	Integrated Community Case Management
ICG	International Coordinating Group
ICRC	International Committee of the Red Cross
IEC	Information, Education, and Communication
IMC	International Medical Corps

IMCI	Integrated Management of Childhood Illness
IMS	Incident Management System
INGO	International Non-Governmental Organization
IPC	Infection Prevention and Control
IRC	International Rescue Committee
IV	Intravenous Fluids
IYCF	Infant and Young Child Feeding
JIAT	Joint Incident Assessment Team
KII	Key Informant Interview
L3	Level 3 Emergency
MAM	Moderate Acute Malnutrition
MoPHP	Ministry of Public Health and Population
MSF	Médecins Sans Frontières
MUAC	Mid Upper Arm Circumference
NNGO	National Non-Governmental Organization
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
OCV	Oral Cholera Vaccine
OFDA	Office of US Foreign Disaster Assistance
ORC	Oral Rehydration Corner
ORS	Oral Rehydration Solution
ORT	Oral Rehydration Treatment
PDM	Post-Distribution Monitoring
RDT	Rapid Diagnostic Test
RRT	Rapid Response Team
SAM	Severe Acute Malnutrition
SLC	Saudi-Led Coalition
TFC	Therapeutic Feeding Center
TPM	Third Party Monitoring
UNICEF	United Nations Children's Fund
UNVIM	United Nations Verification and Inspection Mechanism for Yemen
WASH	Water, Sanitation, and Hygiene
WFP	World Food Program
WHO	World Health Organization
YRCS	Yemen Red Crescent Society



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## EXECUTIVE SUMMARY



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## BACKGROUND:

In 2015, the United Nations (UN) declared Yemen a Level 3 (L3) emergency. On September 28, 2016, a large-scale cholera outbreak began. Between April 27, 2017 and July 1, 2018, more than one million suspected cases in two waves were reported. In the last decade, several large-scale and high mortality cholera outbreaks have occurred during complex humanitarian emergencies including in Iraq, Somalia, and South Sudan. While the issues of “what to do” to control cholera are largely known, context-specific practices on “how to do it” in order to surmount challenges to coordination, logistics, insecurity, access, and politics, remain. During the Yemen cholera outbreak response, questions arose concerning how to effectively respond to a cholera outbreak at a national scale during an existing L3 emergency. The Office of U.S. Foreign Disaster Assistance (OFDA), supported by the Department for International Development (DFID) and the European Civil Protection and Humanitarian Aid Operations (ECHO), provided funding to the Johns Hopkins Center for Humanitarian Health for an unsolicited proposal for a case study of the response.

## OBJECTIVES AND METHODS:

The main objective was to identify lessons from September 28, 2016 to March 2018 (i.e., from the preparedness and detection phase to the end of second wave) to better prepare for future cholera outbreaks in Yemen and similar contexts. The methods included: literature reviews of global cholera guidance, cholera and other outbreak management in complex humanitarian emergencies and fragile states, and documents relating to the outbreak in Yemen; interpretation of surveillance data; and, key informant interviews (KII) with practitioners, donors, and technical experts involved in the response.

## RESULTS:

114 documents were reviewed, and 71 KIIs were undertaken.

- **Reports from Iraq, South Sudan, Haiti, and other complex emergencies and fragile states highlight substantial adaptations undertaken to manage cholera outbreaks.** Global cholera guidance emphasizes the early detection and response to

contain outbreaks at an early stage, a multi-sectoral approach to prevent cholera in hotspots in endemic countries, and effective mechanisms of coordination for technical support, resource mobilization, and partnership.

- **Prior to the outbreak, Yemen did not have a sufficient cholera preparedness and response plan.** There was no plan despite previous cholera outbreaks, endemicity in the region, active conflict, and World Health Organization (WHO) regional office initiatives.
- **The 2016 cholera response plan evolved iteratively, but did not initially prioritize standard components.** Initial gaps including epidemiological analysis to inform the response, and reference to the oral cholera vaccine, community surveillance, and infection prevention and control as well as emerging problems (e.g., improvement of laboratory capacity and monitoring of the application of the case definition).
- **The surveillance and laboratory systems were insufficiently prepared and inadequately modified to monitor the cholera epidemic during a complex emergency.** The large number of suspect cases reported is likely much higher than the actual number meeting the suspect case definition. The lack of systematic use of culture-confirmation and the late adoption of epidemiological investigation and quality control made it difficult to address the high proportion of mild suspect cases. Extensive human resources and logistics were applied to sustain the response, proportionate to caseload, at a national level. Multiple contributing factors included: culture-confirmation needs surpassing the capacity of the only two authorized laboratories; an incentive payment structure inadvertently promoted the inclusion of patients who did not meet the suspect case definition; and lack of early implementation of a system to remotely monitor reporting practices in insecure areas.
- **The treatment network of case management units (diarrhea treatment centers (DTCs) and oral rehydration corners (ORCs)) were insufficiently decentralized and did not ensure adequate access for as much of the population as could have been achieved.** The strategy focused on establishing DTCs (both waves) and ORCs (second wave only) in or near existing health facilities, rather than being driven by

placement near areas of epidemiological need and in more remote areas. Decision-making was driven by the humanitarian need to integrate services due to a lack of human resources and functioning health centers. Despite the rapid scale of infection, technical guidance with attention to high-risk groups like pregnant women and children with severe acute malnutrition were provided with delay. Finally, there was limited focus on community-based approaches to treatment, referral and surveillance.

- **The water, sanitation and hygiene (WASH) sector was unprepared to transition from generalized development-style programming to cholera-specific activities.** It was not until September 2017, after the peak of the second wave, that targeted, outbreak-specific rapid response teams (RRTs) were established, operationalized, and managed at the level of the 22 governorates, leading to specific WASH activities to reduce transmission. A late 2017/early 2018 evaluation by the WASH cluster found that the majority of beneficiaries were reached through system support, including fuel, operations and maintenance support, rehabilitation, and sewage treatment plant support as opposed to cholera-specific interventions.
- **The use of the oral cholera vaccine (OCV) was slowed by the lack of cholera response planning and technical knowledge among the Ministry of Public Health and Population (MoPHP) and partners.** The lack of an updated cholera preparedness and response plan meant that OCV was not integrated into the response mindset and thus, there was a lack of technical knowledge and familiarity with OCV. OCV was not sufficiently discussed during the first wave, and was requested then rejected by the MoPHP during the second wave based on differing conceptions of the overall scale of distribution. The March 2018 plan is the first document that mentions an OCV strategy, based on a January 2018 risk assessment. The MoPHP then made a successful request to the Global Task Force for Cholera Control in April 2018 for 4.6 million doses for preventative use against future surges of cholera.
- **Three coordination systems operated with various success and limited complementarity.** These included the health and WASH clusters and a Cholera Task Force (CTF) and followed by the implementation of the incident management system (IMS) and

emergency operations centers (EOCs) led by WHO. Coordination was also hampered by having two different governments in Yemen and political tensions.

- **Insecurity and airstrikes resulted in extensive damage to civilian infrastructure, including water systems. It likely contributed to service disruptions, reduced access to many areas of the country, and potentially increased cholera transmission.** Other stressors included the closures of ports, airports and blockades of imported food, fuel, medications and medical supplies, and persistent ground-level insecurity.

## CONCLUSIONS:

The cholera response in Yemen was and remains extremely complicated and challenging for a variety of political, security, cultural, and environmental reasons. The study team recognizes these challenges and commends the government, international and national organizations, and the donors for working to find solutions in such a difficult context. There are no easy fixes to these challenges, and the conclusions and recommendations are meant to be constructive and practical, taking into account the extreme limitations of working in Yemen during an active conflict.

The findings were consistent across respondents and methods. The study team found that several areas gained strength throughout the second wave, including: an extensive operational footprint which reached into insecure areas; the strengthening of the collaborations between WHO and UNICEF and the health and WASH clusters; the initiation of a funding mechanism through the World Bank which enabled a timely response at scale; the revitalization of the WASH strategy; and, eventual consensus and use of OCV.

Conversely, the major gaps of this response are rooted in weaknesses in preparedness and the early strategies developed in the first wave. An after-action review after the first wave could have institutionalized these areas in order to prevent a much larger second wave.

The World Bank's commitment to the cholera response provides the rationale for major investment in bolstering the preparedness activities in Yemen and other conflict-affected contexts which would go far for addressing the foundational gaps discussed in this case study.



## TOP 20 RECOMMENDATIONS FOR FUTURE PREPAREDNESS AND RESPONSE

### SURVEILLANCE AND LABORATORY

1. **Global recommendation:** In a complex humanitarian emergency with a weakened public health system, a large, explosive outbreak should be anticipated. The early warning alert and response functions of the surveillance system should be evaluated and primed, such that the surveillance system should be able to handle outbreak detection and response. This includes detection, alerts, routine reporting from health facilities, epidemiological investigation, and patient-level data management required to contain an expanding outbreak as quickly as possible.
2. **Global and Yemen-specific recommendation:** An early priority should be to increase the capacity to culture cholera through the establishment and/or rehabilitation of peripheral laboratories. An improvement strategy for laboratory monitoring of the response should be implemented, including improvements to the capacity to transport specimens.
3. **Yemen-specific recommendation:** A data monitoring plan to improve data collection and identification of challenges at the field level should be implemented jointly by partners. The plan should include training, job-aids, quality control procedures, and guidelines that can be widely understood at the field level.

### COORDINATION AND PREPAREDNESS

4. **Global and Yemen-specific recommendation:** The mandates, roles, and reporting lines of the various coordination structures including the clusters, cholera task force, and incident management system (IMS) urgently require clarification, harmonization, and agreement by the government(s) and partners. Furthermore, according to the WHO's Emergency Response Framework and to ensure a clear mandate, in the future the IMS should be implemented at the beginning of the epidemic, and much earlier than during the peak of the second wave as occurred in Yemen.
5. **Global and Yemen-specific recommendation:** A small set of rapid response teams (RRTs) should be pre-emptively trained and placed on standby to respond to cholera (and other outbreaks), enabling the early targeting of a localized response and containment when there are few case clusters at the beginning or end of the epidemic. In a large-scale cholera outbreak in a crisis-affected country with few decentralized public health resources, health and WASH rapid response teams should be implemented as quickly as possible to support early investigation and response.
6. **Global and Yemen-specific recommendation:** Supervision to improve knowledge, data, and quality of care in more remote areas, by considering various technological solutions (e.g., similar to those used in telemedicine), working closely with national non-governmental organization (NGOs), and by employing third party monitoring (TPM) of data collection, laboratory practices, and quality of practices, needs to be expanded and funded. In Yemen specifically, TPM results from UNICEF need to be examined in order to understand the minimum standards of monitoring and supervision that are achievable even if results cannot be delivered to the country office in real time.

### CASE MANAGEMENT

7. **Global and Yemen-specific recommendation:** Diarrhea treatment center (DTC) and oral rehydration corner (ORC) networks should be mapped according to population and epidemiological needs, particularly in the second and third zones. Smaller treatment units with less bed capacity should be considered for locations closer to communities.

8. **Global and Yemen-specific recommendation:** Cholera preparedness and response plans need to consider contexts with a high burden of acute malnutrition and cholera, and take into account protocols, data, health infrastructure, expertise and materials for managing children affected by both cholera and severe acute malnutrition.
9. **Yemen-specific recommendation:** Build up the function of the health RRTs to provide basic supervision and monitoring of DTCs and ORCs in their catchment area.

## WASH

10. **Global recommendation:** For early control of the epidemic and throughout the outbreak, focus is needed on a strategy providing decentralized, targeted WASH responses to interrupt transmission related to confirmed and suspected cholera cases (case and community- and/or household-based interventions). For example, WASH rapid response teams could be linked to substantive cholera-specific actions such as chlorination in hotspots and hygiene promotion.
11. **Yemen-specific recommendation:** Consider the appropriate role of all partners in a response, including agency, government, INGOs, NNGOs, and private sector. In particular, consider alternative approaches to the provision of remote support, such as video-based trainings, ensuring a help-desk feature for their field staff with rapid turnaround on technical questions, more proactive remote support, and the development of implementing partner relationships with local NGOs and associations where feasible.
12. **Yemen-specific recommendation:** Donors, the WASH cluster, and the Ministry of Water should strategize and complete as much rapid work on water supply and sanitation infrastructure as possible. These efforts should occur while simultaneously advocating and partnering with large bilateral and multilateral donors (e.g., World Bank) on repairing and maintaining infrastructure for medium to long-term prevention of water-borne diseases. This can be facilitated by ensuring there are WASH specialists trained on infrastructure repairs, operations, and maintenance able to work in Yemen.

## INTEGRATED HEALTH AND WASH RESPONSE

13. **Global and Yemen-specific recommendation:** Planning should always be integrated between the health and WASH sectors on the following strategies and interventions: (a) decentralized health and WASH RRTs that share epidemiological data, target their responses, and integrate their responses; (b) joint planning of oral cholera vaccination (OCV) among the MoPHP, WHO, UNICEF, and health and WASH clusters; (c) the provision of infection, prevention, and control in health facilities; and (d) water quality surveillance in support of epidemiological surveillance.
14. **Yemen-specific recommendation:** Given the severe insecurity and remote context in much of Yemen, decentralization of care with community-based approaches to treatment, referral and WASH should be the focus in rural and remote areas: (a) placing ORCs within a one hour walk of communities as a minimum standard (and supporting transport to diarrhea treatment centers); (b) organizing cross-agency community health networks and developing capacities for community-based surveillance, referral to care, staffing of ORCs, and social mobilization and health and hygiene promotion; and (c) strengthening the roles of international agencies and INGOs as technical advisors to NNGOs who may have more access to communities.
15. **Yemen-specific recommendation:** The response needs to assure that the model for remote technical assistance is effective, accessible, and timely. Major technical bodies should provide cholera-specific, multi-day training modules for mixed groups of frontline public health staff from NNGOs and INGOs in Amman or Djibouti to improve the understanding of a cholera-specific response. In addition, a minimum set of standardized practices and measures should be developed for agency-level remote monitoring and supervision of the cholera response.

- 16. Global recommendation:** After-action reviews of practice after a cholera outbreak should be standard practice for each responding organization. An after-action review for each agency (UN, INGOs, NNGOs, etc.) after the first wave would have been beneficial for identifying gaps and weaknesses in preparedness that required resolution before the second wave occurred.
- 17. Global and Yemen-specific recommendation:** NGOs should develop remote monitoring processes (e.g., field procedures, tools and checklists, accountability mechanisms) for assuring the quality and scale of intervention in remote and insecure sites. For cholera, this could mean rigorous procedures for use of free residual chlorine as a monitoring indicator and providing TPM on a systematic basis for monitoring care in DTCs and ORCs.

#### ORAL CHOLERA VACCINATION

- 18. Global recommendation:** Different scenarios for OCV according to varying contexts should be integrated ahead of time into national cholera preparedness plans in general. This is especially important for ‘fragile’ countries where there is a possibility of humanitarian emergencies developing or continuing.
- 19. Global and Yemen-specific recommendation:** In complex and insecure environments like Yemen, smaller, geographically-targeted OCV campaigns should be anticipated and planned.

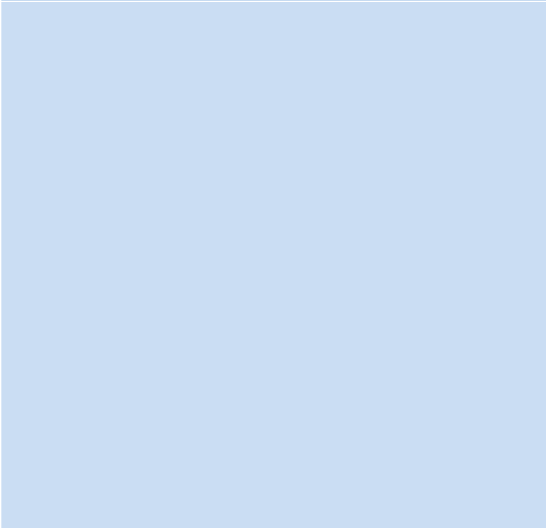
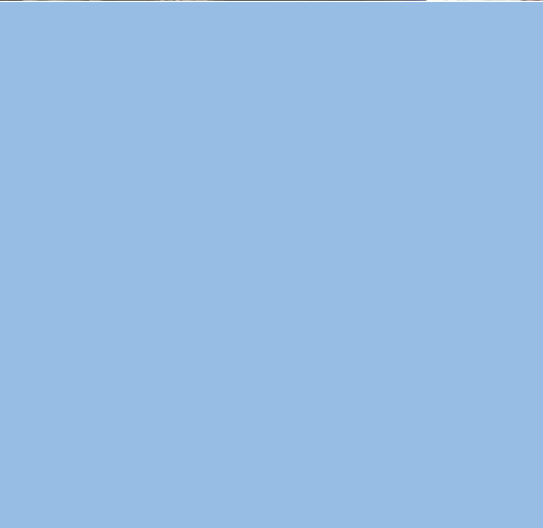
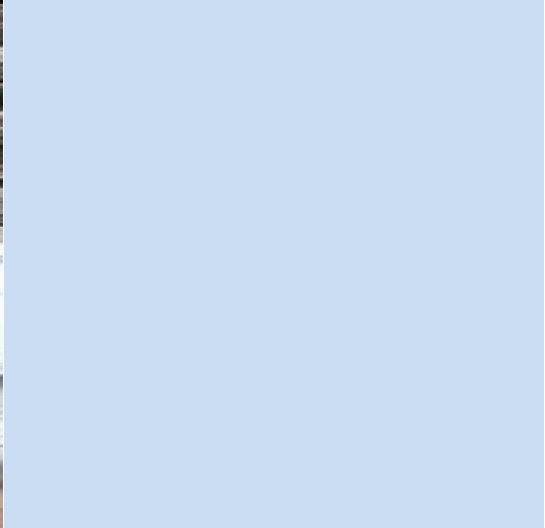
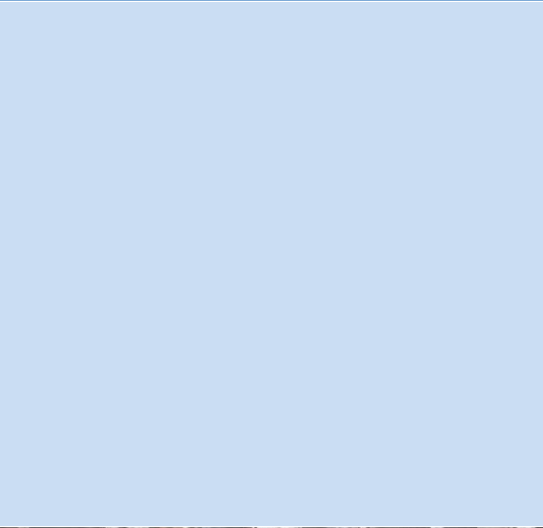
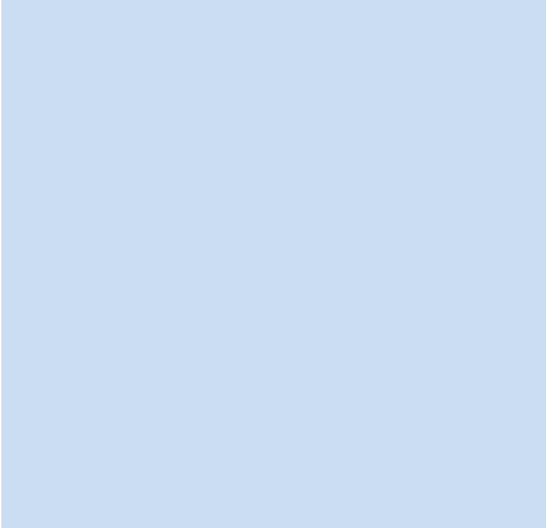
#### INSECURITY

- 20. Yemen-specific recommendation:** Attacks on health, water and sanitation infrastructure should be terminated. The UN should adopt a stronger stance on the protection of both health facilities as well as water and sanitation infrastructure. Besides proactively sharing the locations with the Saudi-led Coalition, monitoring and documenting attacks against this infrastructure using a geo-located database system with systematic reporting should be undertaken.

## ACKNOWLEDGEMENTS

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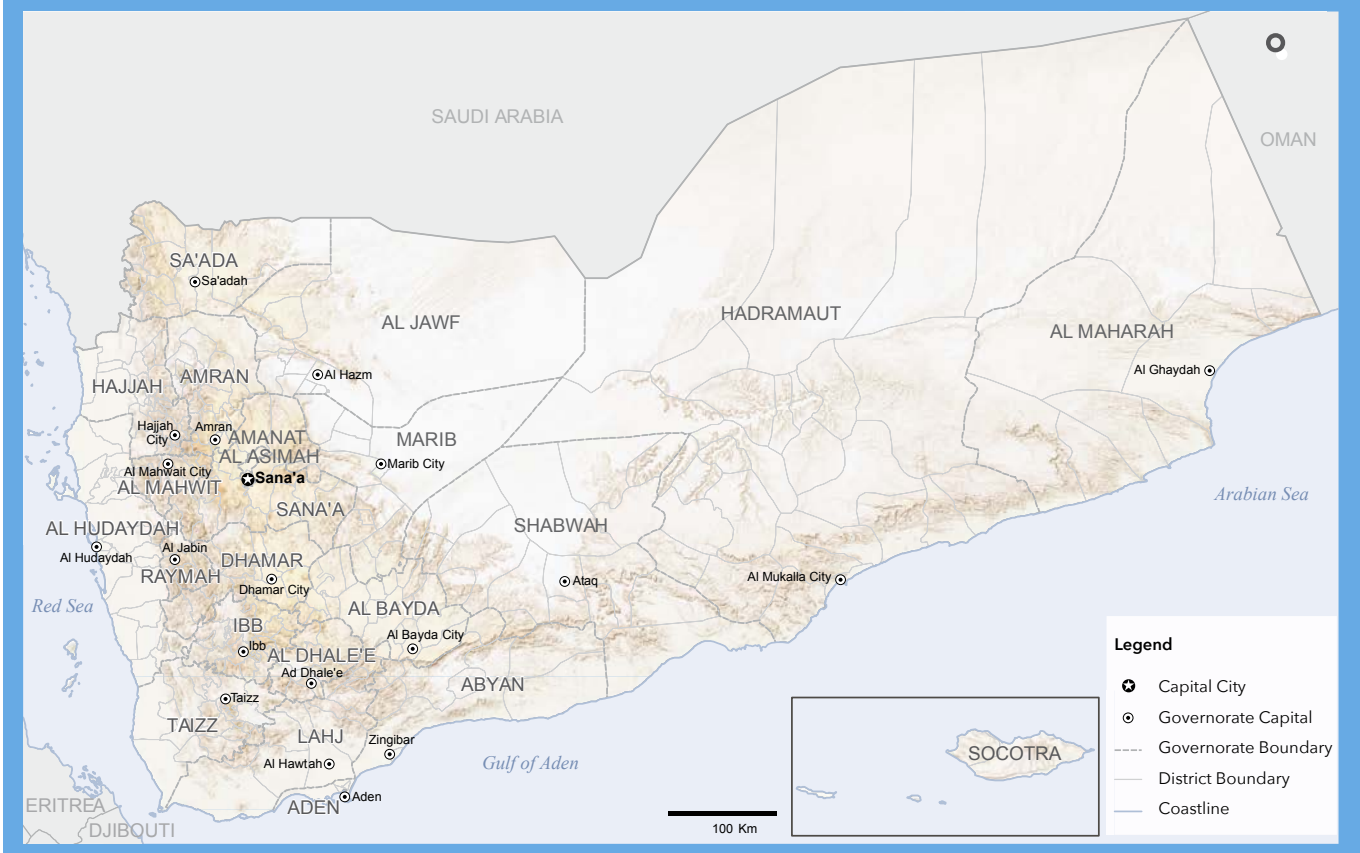
# 1. INTRODUCTION

Cholera is a diarrheal disease which results from infection with *Vibrio cholerae* of the O1 or O139 serogroups.<sup>1</sup> Its symptoms and signs include continuous bouts of profuse diarrhea leading to severe dehydration and death, if untreated. Oral rehydration solution (ORS) is the standard treatment for cholera, alongside the provision of intravenous fluid (IV), when indicated.<sup>1,2</sup> The prevention and control of cholera are linked with improvements in water and sanitation infrastructure and the maintenance of hygienic behaviours.<sup>3</sup>

Cholera is now endemic in parts of Africa, Asia, and the Middle East among populations that have poor access to safe water, sanitation, and health care.<sup>1</sup> Cholera outbreaks are common in Sub-Saharan Africa and the Middle East, with several large, high-mortality outbreaks occurring in the last decade in Iraq, Sierra Leone, Somalia, South Sudan, Tanzania, Zimbabwe, and Yemen. Common among these countries is conflict, political instability, and/or displacement. This gives rise to risk factors for cholera emergence such as the degradation of health and water and sanitation infrastructure and the pooling of susceptible persons.<sup>4</sup> While “what to do” to prevent and control are largely known for cholera, context-specific practices on “how to do it” in order to surmount challenges to coordination, logistics, insecurity, access, and politics are needed.

Yemen borders Saudi Arabia and Oman and is separated from East Africa by the Red Sea and the Gulf of Aden (Fig 1). It is one of the most water-insecure countries in the world.<sup>5</sup> Since 2014, Yemen has been in a complex and deadly civil war between government forces of Abdrabbuh Mansur Hadi (Loyalists) mainly in the south,

**Figure 1: Map of Yemen** (Source: OCHA, 2017)<sup>10</sup>



supported by the Saudi-led Coalition Forces (SLC), who are backed by the US, the UK, and the Houthi forces in an alliance with the forces loyal to the former President Saleh in the north. The government is also officially divided into two factions. As with other conflicts in the Middle East, there is a regional component of Sunni Islam (supported by Saudi Arabia) and Shia Islam (supported by Iran). Civilians in the north have endured airstrikes on civilian infrastructure by the SLC and in the south, there is a separatist movement.

In 2015, the United Nations (UN) declared Yemen a Level 3 (L3) emergency which activated the highest level of resource mobilization possible across the humanitarian system.<sup>6</sup> By September 2016, only 46% of the 3,507 hospitals and clinics were operating<sup>7</sup> and blockades of the Red Sea ports prevented the entry of key goods. Extreme insecurity restricted the general movement of civilians, and local and international non-governmental organizations (NGOs). Since 2017, severe food insecurity has put 17 million persons, more than half of the population, at risk.<sup>8</sup> A diphtheria outbreak was declared in late 2017, indicating the collapse of the routine immunization system. At present (December 2018), fighting around the Hodeidah port in the north threatens civilian populations across the governorate, and airstrikes continue to kill civilians.<sup>9</sup>

It was in this context that cholera has struck Yemen. The last recorded cholera outbreak in Yemen was in 2011, and was extinguished after recording approximately 30,000 suspected cases.<sup>12</sup> By January 2018, the current outbreak has resulted in more than one million suspected cases.<sup>13</sup> Amidst the degradation of water and sanitation infrastructure, displacement, pre-famine conditions and widespread malnutrition, and an increased reliance on surface water due to flooding in the rainy season, the cholera outbreak erupted in September 2016 in Sana'a, with a small number of cases spreading to Aden and elsewhere.<sup>14</sup> Two months later, cases were reported in 15 of the 21 governorates. The epidemic slowed, but erupted suddenly in May 2017 producing a second wave.

## YEMEN'S CHOLERA EPIDEMIC IN NUMBERS

(Apr 27, 2017 - Jul 1, 2018)<sup>11</sup>

### 1,115,378 suspected cases

- **Attack rate: 397 suspected cases per 10,000 population**
- **2,310 deaths (CFR <1%)**
- **15.7% severe cases**
- **28.8% children under five years**

### All 333 districts affected

- **162 (49%) of districts continue to report suspect cases in the three weeks up to July 1, 2018**

Given the complex and insecure operating environment, and the confluence of humanitarian actors responding to the cholera outbreak (a split government and Ministry of Public Health and Population (MoPHP); actors from the water, sanitation and hygiene (WASH), health, and nutrition sectors; a multitude of UN agencies, and local and international responders), the response is considered one of the most challenging in the world. The Office of U.S. Foreign Disaster Assistance (OFDA), supported by the Department for International Development (DFID) and the European Civil Protection and Humanitarian Aid Operations (ECHO), provided funding to the Johns Hopkins Center for Humanitarian Health for an unsolicited proposal for a case study. The team's affiliations and expertise is outlined in Annex 1.

The main objectives of the case study are to identify lessons learned from the cholera response to better prepare for future potential outbreaks in Yemen and to provide recommendations for future epidemics in Yemen and other countries with complex humanitarian emergencies and poor operating environments. The secondary objectives include the documentation of the decision-making process around the response in the health, WASH, and nutrition sectors, and to undertake a qualitative and quantitative analysis of the response taking into account the specific context of Yemen.

## 2. METHODS

An explanatory case study approach was undertaken. The case study covers the period of emergence of cholera from September 28, 2016 to the end of the second wave in July 2017, with reference to future anticipated endemicity.

Derived explanations were supported by chains of evidence based on data collected using the following methods, including a literature review, interpretation of surveillance data, and key informant interviews:<sup>15</sup>

- A **literature review** of global cholera guidance including cholera guidelines, best practices for outbreak control in complex humanitarian emergencies, and remote programming and monitoring was undertaken. The websites of major responding international organizations were reviewed. A PubMed search was also undertaken to investigate cholera responses in fragile states and complex humanitarian emergencies in order to develop a framework for cholera response in complex humanitarian emergencies.
- A **Yemen-specific cholera literature review**, including cholera preparedness and response plans, epidemiological situation reports, evaluations, needs assessments, monitoring reports, meeting notes, presentations, internal reports, peer-reviewed articles, and news articles, was undertaken to analyze decision-making, policy, and actions taken.
- An **interpretation of surveillance data**, including key cholera indicators (e.g., attack rate, case fatality ratio, proportion of cases under five years of age) and trends in surveillance data were undertaken to describe and interpret the outbreak by person, place, and time; This included a spatial mapping of cholera

indicators and a basic epidemiological interpretation of the epidemiological curve and key indicators presented in a previously published report on the modelling of surveillance data from the outbreak.<sup>13</sup>

- **Key information interviews (KIIs)** with public health practitioners, donors, and technical experts in cholera who contributed to the response were undertaken. A stakeholder analysis was conducted to understand the network of actors who should be interviewed.<sup>16</sup> KII data explained how decisions were made, how actions were carried out, and personal perspectives on the response. Respondent selection aimed to achieve balance across sectors, and time periods during the outbreak.

KIIs were 30 to 60 minutes in length and were undertaken over phone, Skype or Zoom, or in person. Participants who were interviewed had the option to be affiliated by name, organization, type of organization, or to remain anonymous. Follow-up interviews were conducted as needed. To ensure accuracy in note-taking and interpretation, most KIIs involved more than one team member or interviews were recorded. Interview guides were prepared for seven thematic areas (preparedness, surveillance and laboratory, case management, WASH, oral cholera vaccine (OCV), nutrition, and security). Detailed notes or transcription of recorded interviews were taken. For the analysis, transcripts and notes were reviewed with supporting materials to identify key themes, concerns, and observations.

A mixed-methods approach using an embedded design was used where the KII results provided the main source of information supplemented and triangulated by epidemiological data. Team-based analysis was done periodically over the phone on a monthly basis and in person during two meetings at Johns Hopkins University to build a wider interpretation across the sectors and a comprehensive understanding of how the response was run and to formulate new questions to guide future KIIs. Sections of the final report were shared confidentially with selected stakeholders to verify information and interpretations.



## 2.1 ETHICAL REVIEW

The project was determined by Johns Hopkins Bloomberg School of Public Health not to be human subjects research, and therefore did not require institutional review board oversight. No known beneficiaries of the cholera response were participants in this case study and only persons in their professional capacity were interviewed.

## 2.2 LIMITATIONS

There were several limitations to this case study:

- 1) Due to the difficult nature of entering Yemen on the humanitarian roster, the study team was unable to visit Yemen to conduct KIIs in person and to observe programs, despite numerous attempts to do so. The team instead scheduled several interviews with respondents to build rapport and maximize the accuracy of their responses. Nevertheless, there was considerable variation and discrepancies among respondents within and among different organizations on numerous issues.
- 2) As the case study is retrospective, there is recall bias.
- 3) The review focused on the perspectives of responders and did not specifically include the perspectives of beneficiaries who received care.
- 4) There was turnover of key staff in Yemen between the 2016 and 2018, which made assessment of the larger picture of preparedness and response difficult.
- 5) As is often the case in emergencies, little data existed to ground truth the responses, and the available data was of varying quality. Given the lack of data, it is worth mentioning that in some cases, key internal plans and data discussed in interviews were not provided by some respondents, despite repeated requests. The study team worked to use available quantitative and qualitative data to triangulate findings.
- 6) A limited number of NNGOs and no MoPHP representatives were interviewed, despite numerous requests for introductions by the UN agencies and direct requests from the study team. Representatives from the Water Ministry (General Authority for Rural Water Supply Projects or GARWSP) were interviewed.
- 7) The current Humanitarian Coordinator (March 2018 onwards) was unavailable to be interviewed, though the previous Humanitarian Coordinator was interviewed, and
- 8) The objectives of the case study were to cover the periods of the first and second wave (September 2016 to March 12, 2018), thus we have not taken into account information past March 12, 2018.





## 3. RESULTS

We completed the literature reviews and conducted 71 KIIs. KII respondents included representatives from Action Contre la Faim (ACF), Canadian Red Cross, Yemen Red Crescent Society (YRCS), CARE, Centers for Disease Prevention and Control (CDC), Center for Civilians in Conflict (CIVIC), DFID, ECHO, Epicentre, International Rescue Committee (IRC), GARWSP, Health, Nutrition, and WASH clusters, Human Rights Watch, International Committee of the Red Cross (ICRC), International Medical Corps (IMC), Médecins Sans Frontières (MSF) Holland, MSF Spain, Office for the Coordination of Humanitarian Affairs (OCHA), OFDA, OXFAM, Relief International, Save the Children, SOUL for Development, UNICEF (country office/Middle East and North Africa Regional Office (MENARO)/HQ), World Health Organization (WHO) (country office/Regional Office for the Eastern Mediterranean (EMRO)/HQ), the UN Humanitarian Coordinator, and the World Bank. A list of the organizations interviewed is provided in Annex 2.

In the following sections, the key results of the literature reviews and KIIs are summarized first by sector (including global guidance, surveillance, preparedness and strategy, case management and health, WASH, integrated health and WASH strategies, OCV, acute malnutrition and cholera treatment) and then by cross cutting themes across sectors (including communication, insecurity, coordination, and global research and standards).

### 3.1 LITERATURE REVIEW OF GLOBAL GUIDANCE

Two literature reviews were conducted, one on general cholera response in complex humanitarian emergencies and fragile states, and another specifically on cholera preparedness and response in Yemen. The websites of the Global Task Force for Control (GTFCC), WHO, the UN Children’s Fund (UNICEF), Global Clusters, and MSF Field Research were reviewed for relevant documents on global cholera guidance. A PubMed search was conducted to find peer-reviewed articles relevant to cholera and other outbreak control in complex humanitarian emergencies and fragile states. Websites including ReliefWeb, WHO, Humanitarian Response, Devex, IRIN News, and the Global Cluster sites were searched for Yemen-specific documents. During interviews, agency-specific documents were requested from respondents.



To frame the literature review, we highlight the three approaches that the GTFCC recommends to control cholera and minimize cholera mortality:

- *Early detection and quick response to contain outbreaks at an early stage*, including early warning surveillance systems, pre-positioning stocks, preparedness of WASH systems, preparedness of the health care system and improved health care facility infrastructure, establishment of WASH and health rapid response teams (RRT), maintenance of stocks of WASH supplies, specific WASH interventions to prevent spread of disease, community engagement, mass vaccination campaigns with OCV, and effective supply management;
- *A multisectoral approach to prevent cholera in hotspots in endemic countries*, including identification of hotspots requiring priority action, analysis of local transmission patterns, and implementation of a package of control measures adapted to local transmission patterns; and
- *An effective mechanism of coordination for technical support, resource mobilization, and partnership at the local and global level.*

### 3.1.1. CHOLERA RESPONSE IN COMPLEX HUMANITARIAN EMERGENCIES AND FRAGILE STATES

Twenty-four documents relating to global guidance for cholera were found and 32 peer-reviewed articles or reports relating to cholera and other outbreak control in complex humanitarian emergencies and fragile states were found.

A multi-sector cholera response (involving coordination, case management, WASH, social mobilization, and OCV) to control cholera is well-defined in the literature and in practice. However, the prime concern in complex humanitarian emergencies and fragile states is the delivery of the interventions in such constrained contexts. Interventions need to be adapted and simplified, and require coordination amongst UN, international and NNGO, Red Cross/Red Crescent Movement, and government actors.<sup>17</sup> The matrix below is based on the literature review of global cholera guidance conducted by the authors (Table 1) and describes adaptations for cholera (and other) outbreak response in complex humanitarian emergencies and fragile states. These adaptations are intended to fill gaps in systems, address insecurity, and provide short-term versus longer-term impacts. A cholera response strategy should reflect such adjustments to the emergency context.



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**Table 1: Cholera and outbreak response interventions, challenges, and adaptations in complex humanitarian emergencies (CHE)**

Objective	Recommended intervention	Main challenges in CHEs	Adaptations for CHEs
<b>Coordination of actors</b>	<ul style="list-style-type: none"> <li>Establishment of a cholera task force to establish technical guidance and standard operating procedures, coordinate actors, and facilitate decision-making<sup>18,19</sup></li> </ul>	<ul style="list-style-type: none"> <li>Cluster approach or other coordination approaches for crises may already exist and may be overwhelmed by other functions related to the pre-existing crisis</li> <li>Technical expertise in cholera outbreak response may not necessarily exist within the clusters</li> </ul>	<ul style="list-style-type: none"> <li>Separate the role of clusters (i.e., implementation/coordination) from task force (i.e., technical expertise): <b>Zimbabwe</b><sup>20,21</sup></li> <li>Development of Incident Management Systems (IMS) to improve communication and decision-making: <b>Northern Nigeria (crisis), Sierra Leone (EVD)</b><sup>22-24</sup></li> </ul>
<b>Reduce transmission</b>	<ul style="list-style-type: none"> <li>Rapid detection of cases and clusters</li> <li>Routine surveillance to produce cholera-specific data to guide the local response</li> <li>Routine monitoring of cholera through systematic use of sentinel site, RDTs and culture</li> <li>Social mobilization</li> </ul>	<ul style="list-style-type: none"> <li>Surveillance system is not functional, coverage is low, and human and technical resources are scarce</li> <li>Limited access of populations to health care in order to treat and identify cases (due to non-functional health systems; population displacement)</li> <li>No systems for identifying and tracking mortality exist</li> <li>Limited response capacity for alerts</li> <li>Laboratories not functional and/or there are few of them</li> </ul>	<ul style="list-style-type: none"> <li>Adapt surveillance system to prioritize the early detection of outbreaks, investigation, and rapid response<sup>25</sup></li> <li>Conserve resources by targeting response to hotspots (using data and decentralized and intensified response efforts): <b>Haiti</b><sup>26</sup></li> <li>Supplement surveillance system with alert and response surge capacity through rapid response teams (RRT): <b>Haiti</b><sup>26</sup></li> <li>Use community health worker/volunteer networks (CHW/CHV) to extend surveillance and track mortality in communities for early warning of outbreaks: <b>Somaliiland, Sierra Leone (EVD), Guinea (EVD)</b><sup>27-30</sup></li> <li>Use a feasible and modified laboratory protocol that extends ability to culture specimens (i.e., sentinel site laboratory testing; rehabilitating non-functional labs to develop capacity): <b>Iraq, Papua New Guinea</b><sup>20,31</sup></li> </ul>
	<ul style="list-style-type: none"> <li>Short-term WASH interventions at household and community level</li> <li>Improve water quality</li> <li>Improve water supply</li> <li>Short-term hygiene promotion for cholera</li> </ul>	<ul style="list-style-type: none"> <li>Bandwidth of WASH actors already in country is usually low</li> <li>Funding and resources are scarce and interventions are costly</li> <li>Difficult to gain access to households due to insecurity</li> <li>Long-term sanitation improvement not possible</li> <li>Behavior change alone takes too long to see impacts and there are limited resources to realize behavior changes</li> </ul>	<ul style="list-style-type: none"> <li>See<sup>32-34</sup></li> <li>Place chlorine into system at different points: <b>Syria</b><sup>33</sup></li> <li>Routine free residual chlorine testing</li> <li>Conserve resources by targeting response to hotspots (using data and local teams)</li> <li>Use of targeted C4D strategies</li> <li>Use community-based network to deliver messaging (and oral rehydration points (ORPs)</li> </ul>

Objective	Recommended intervention	Main challenges in CHEs	Adaptations for CHEs
<b>Reduce mortality</b>	<ul style="list-style-type: none"> <li>Health promotion to seek care as early as possible</li> </ul>	<ul style="list-style-type: none"> <li>Difficult to bring communities closer to care because of insecurity</li> <li>Transportation to treatment centers is limited/ unaffordable</li> </ul>	<ul style="list-style-type: none"> <li>Use community-based network to deliver messaging, treatment and/or referral to services (and ORPs): <b>Somaliland</b><sup>27,28,30</sup></li> </ul>
	<ul style="list-style-type: none"> <li>Quality treatment through a network of cholera treatment centers (CTCs), smaller CTUs, and ORPs close to communities</li> </ul>	<ul style="list-style-type: none"> <li>Difficult to get case management network close to need because of insecurity</li> <li>Difficult to monitor quality and infection, prevention and control (IPC) in facilities</li> <li>Human resources for health limited</li> </ul>	<ul style="list-style-type: none"> <li>Develop network of units that provide access to care within 24 hours (including ORPs close to communities): <b>Somaliland</b><sup>18,35</sup></li> <li>Third party monitoring in facilities<sup>36</sup></li> </ul>
	<ul style="list-style-type: none"> <li>ORPs place close to more remote/rural communities to reduce severity of dehydration</li> </ul>	<ul style="list-style-type: none"> <li>Few actors to run ORPs</li> <li>Few means of referral of severe cases from ORP to CTC</li> <li>Lack of acceptance of ORT as treatment by population</li> </ul>	<ul style="list-style-type: none"> <li>Develop network of units that provide access to care within 24 hours (including ORPs close to communities)<sup>18,35</sup></li> </ul>
<b>Reduce risk of infection</b>	<ul style="list-style-type: none"> <li>Medium-term WASH interventions at community level (water supply, waste and sewage, hygiene promotion)</li> </ul>	<ul style="list-style-type: none"> <li>Humanitarian donors do not fund these interventions</li> <li>Bandwidth of limited WASH actors is usually low</li> <li>Resources are scarce</li> <li>Difficult to gain access to households due to insecurity</li> </ul>	<ul style="list-style-type: none"> <li>Planning around preventative interventions targeted at the next outbreak</li> <li>Preventative vaccination of hard to reach/insecure populations using OCV<sup>37-39</sup></li> <li>Hygiene promotion with long-terms impacts is likely too ambitious</li> </ul>
	<ul style="list-style-type: none"> <li>Hygiene promotion targeting long-term behavior change</li> </ul>	<ul style="list-style-type: none"> <li>Activities are short term, and unlikely to rapidly change behaviors</li> <li>Essential resources to render behavior change effective are scarce or unavailable (e.g., improved latrines for safe sanitation)</li> </ul>	<ul style="list-style-type: none"> <li>Adequate community preparedness and action planning (versus ad-hoc community campaigns)<sup>18</sup></li> <li>Ensure communication is paired with provision of goods<sup>18</sup></li> <li>Emphasize messaging by community health workers, hygiene promoters and other community agents<sup>40</sup></li> </ul>
	<ul style="list-style-type: none"> <li>Oral cholera vaccine</li> </ul>	<ul style="list-style-type: none"> <li>Materials too bulky</li> <li>Cold chain not available</li> <li>Difficult to assure two doses</li> <li>Changing population denominators</li> <li>Expect reduced herd immunity</li> <li>Poor data to base targeting of vaccine</li> </ul>	<ul style="list-style-type: none"> <li>Physical modifications to vaccine container (controlled cold chain, plastic vial)<sup>39,41</sup></li> <li>Preventative vaccination of hard to reach/insecure populations using OCV: <b>Iraq, South Sudan</b><sup>37-39</sup></li> <li>One-dose strategies to assure short-term protection, followed by delayed second dose (if possible): <b>Democratic Republic of Congo, South Sudan</b><sup>37,39,42,43</sup></li> <li>Use of existing polio vaccination infrastructure: <b>Northern Nigeria, Somalia</b><sup>44,45</sup></li> <li>Door to door campaigns to augment fixed and mobile vaccination sites: <b>Somalia</b><sup>44</sup></li> </ul>



### 3.1.2. CHOLERA IN THE MIDDLE EAST, EAST AFRICA, AND YEMEN (2000 TO PRESENT)

In East Africa and the Middle East, large, high-mortality cholera outbreaks are routinely reported. This indicates the consistent presence of cholera in both regions surrounding Yemen. In Somalia, annual outbreaks were reported in 2011 (77,636 cases, 1,130 deaths, CFR=1.46%) through to 2016 (15,619 cases, 534 deaths, CFR=3.5%).<sup>44</sup> Iraq reports outbreaks approximately every two years. Conflict, famine, acute malnutrition, poor WASH infrastructure and hygiene practices, and displacement contribute to the rapid regional dissemination of cholera in both countries.

The confluence of risk factors in Yemen has given rise to explosive disease outbreaks. This includes dengue (2016), measles (2017-current), and diphtheria (2017-current), while poliomyelitis remains a threat.<sup>45</sup> Cholera is not considered endemic in Yemen, as this would require local transmission occurring over three of the past five years. It follows that preparedness measures were therefore not commensurate with a cholera-experienced country. Small outbreaks of 55 to 300 cases were reported in 2009 and 2010 after an interepidemic period of 15 years. In 2011, a large outbreak of around 30,000 acute watery diarrhea (AWD)/suspected cholera cases (attack rate 1.4%) with 134 deaths (case fatality rate (CFR)<1%) was reported in the southern governorates of Aden, Abyan, and Al-Dhale'e with fewer cases in Lahj and Ibb.<sup>12</sup> The outbreak was driven by the degradation of WASH infrastructure and health services due to conflict.

### 3.1.3. HEALTH SYSTEMS IN YEMEN (2000-PRESENT)

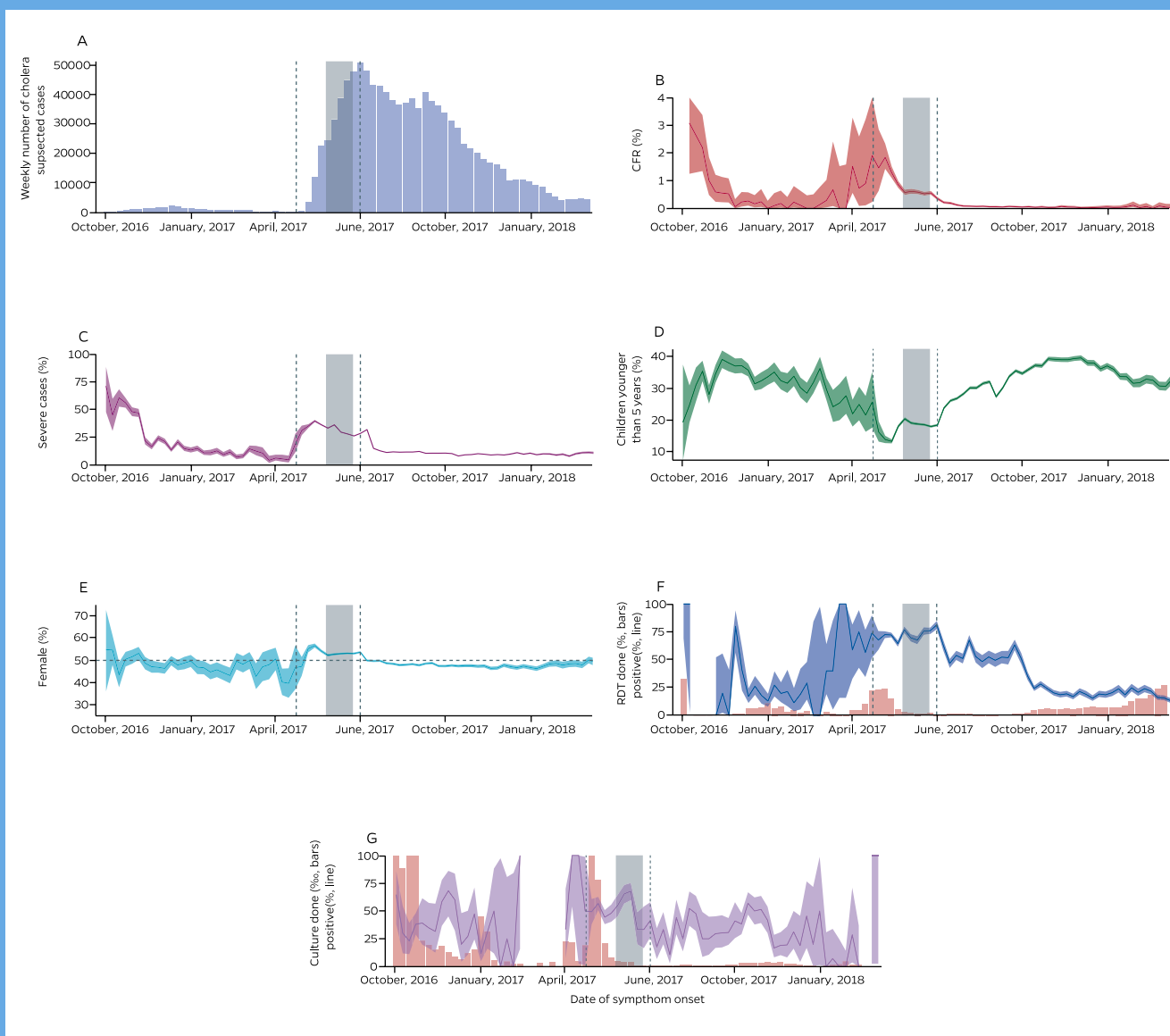
Before the current conflict began in 2015, the health system was weakened by poor access in rural areas and a high proportion of out-of-pocket expenditure.<sup>46</sup> While reductions in infant mortality and maternal mortality before 2015 were observed, the recent conflict further strained access to health care, health financing, security of communities, the capacity of health facilities and health workers and, nutritional status. Prior to the conflict, Yemen's diphtheria/polio/tetanus coverage were considered stable at 70 to 80%; by November 2015 coverage dropped to 54%.<sup>46</sup> The country is reliant on regional and national mass vaccination campaigns, with a strong polio vaccination infrastructure.

## 3.2 SURVEILLANCE AND LABORATORY

In this section, surveillance results including information from the surveillance review and the KIIs related to surveillance are presented.

To rapidly detect and verify the existence of a cholera outbreak and limit its spread, the capacity for early detection and laboratory confirmation is critical.<sup>19</sup> The harmonization of surveillance and laboratory systems underpins this function. Surveillance provides key information for which decision-making regarding the allocation of limited prevention and control resources are made.

Cholera outbreaks demand a rapid cycle of detection, verification, and response which usually outstrips the capacity of the national surveillance system to support real-time monitoring.<sup>26</sup> In Yemen, the collapse of the health system and the lack of access to health care in remote settings further reduced the capacity of the surveillance system. A cautious interpretation of the surveillance data and an analysis of the surveillance and laboratory systems can therefore demonstrate what is known and unknown regarding the cholera burden.

**Figure 2: Cholera surveillance in Yemen, Sept 2016-Mar 2018<sup>13</sup>**

### 3.2.1. EPIDEMIOLOGICAL INTERPRETATION

Key trends are presented in Figure 2 (This figure has been reproduced under the terms of the [Creative Commons Attribution License \(CCBY\)](https://creativecommons.org/licenses/by/4.0/) from the article by Camacho et al (2018) available here: [https://doi.org/10.1016/S2214-109X\(18\)30230-4](https://doi.org/10.1016/S2214-109X(18)30230-4)).<sup>13</sup> AWD cases were first reported in Sana'a in late September 2016. The MoPHP declared the outbreak a week later on October 6, 2016, based on 11 culture-confirmed cases (*Vibrio cholera*

O1, serotype Ogawa) from Sana'a and four confirmed cases from neighboring Al-Bayda.<sup>47</sup> This was followed by suspected cases detected in Hodeidah on the north coast.<sup>48</sup> The period of time between this initial detection and declaration of the outbreak by the MoPHP was very short, but as discussed in an internal evaluation by UNICEF, the disease may have been circulating for a longer period before its detection.<sup>49</sup> This first wave lasted seven months (September 28, 2016—April 23, 2017) with 25,839 suspected cases 1,663 deaths and 181

(36.9%) of 491 samples confirmed. Thirty three percent of suspected cases were among children under 5 years. An epidemic trough followed, with a rapidly increasing trend over two months (*increasing phase of the second wave*, as marked by the dotted lines, April 24-July 2, 2017). This was followed by a gradually decreasing trend over eight months (*decreasing phase*, July 3, 2017-March 12, 2018, 800,677 suspect cases, 602 deaths). The short *increasing phase* occurred at the onset of the rainy season. The rapid onset of the second wave was associated with the accumulation of susceptible persons possibly due to a shift from the use of deep well water to the use of contaminated surface water during the rains.<sup>13</sup> The increasing phase in the second wave presents the hallmarks of cholera transmission:

- A sharp ascent consisting of synchronous bursts of transmission across nearly the entire Western area over a two-month period leading to a single large and broad peak and a relatively high cumulative attack rate comparable to anticipated standards (0.1-2% in large scale outbreaks);<sup>33</sup>
- A declining proportion of suspect cases among children under five years (18.3% in the first wave). This compares with similar proportions among children under five in Haiti, 2010-2012 (13.1%), and South Sudan, 2014 (21.9%);<sup>50,51</sup> and
- A high CFR (>2%), proportion of severe cases (30.6%) and rapidly descending CFR (<1%) at the onset, is typically linked to lack of access to treatment followed by the rapid scale-up of DTCs.<sup>33</sup>

While the proportions of rapid diagnostic test (RDT)-positive and culture-positive results appear high (>50%), RDT and culture use were not done systematically, and reliable interpretation is not possible.

In contrast, the trends in the first wave and the decreasing phase appear atypical for cholera, and suggest a large proportion of endemic diarrhea of other origin (e.g., rotavirus, norovirus, and other diarrheal disease). For instance, the decreasing phase has multiple peaks over eight months, rather than a steep decline indicating exhaustion of susceptible persons. There are high proportions of children under five years (>30%) and the proportion of severe cases is low (first wave: 18.6%; decreasing phase: 11.9%).

*National surveillance [during the 1st wave] wasn't up to the mark of tracking cholera effectively.*

Senior Manager, speaking on the 1<sup>st</sup> wave

*[We realized that] it's not just where we are [in Aden], it's everywhere, and it's intense everywhere.*

Field Epidemiologist, onset of 2<sup>nd</sup> wave

*We were seeing hundreds of cases a day. Within a week, it was 3,000 cases a day. Nobody could respond at this level.*

Senior Manager, onset of 2<sup>nd</sup> wave

*Because people were so vulnerable and they were hanging on, hand to mouth, the rapid spread and magnitude was then believable.*

Senior UN Official, onset of 2<sup>nd</sup> wave

*[Overreporting] didn't really matter as the treatment is the same for rotavirus and cholera. It was more about [epidemiological] sensitivity and people getting treated.*

Epidemiologist, reflecting on two years of data

### 3.2.2. SURVEILLANCE AND EARLY WARNING SYSTEMS WERE PRESENT BUT NOT OPTIMIZED FOR OUTBREAK CONTROL

Surveillance systems in complex emergencies must focus on the early detection of outbreaks to facilitate rapid response and containment.<sup>23,52</sup> Recognizing this, in 2013 the MoPHP and WHO implemented a sentinel site network to provide an early warning system for outbreaks (Electronic Disease Early Warning System (eDEWS)).<sup>53,54</sup> However, the system was not primed for a large outbreak, and collapsed when cholera transmission increased rapidly. eDEWS used mobile phones to provide immediate reporting of high-priority disease syndromes, weekly reporting of 31 diseases, and alert notification of potential outbreaks across a 400-facility sentinel site network in four governorates. By December 2016, two months after the declaration of the cholera outbreak, eDEWS expanded to nearly half of all governorates (n=1,982) and its reporting was integrated with routine surveillance.<sup>55</sup> eDEWS initially provided “a dense network of public and private facilities who were ready to collect data” across the country (Field Epidemiologist). However, the

infrastructure was quickly overwhelmed by the outbreak’s rapidly increasing caseload, and the lack of a means for systematic investigation and response to alerts. The burden of reporting for 31 diseases was too large to sustain. Alert management was organized centrally from Sana’a which meant eDEWS lacked the ability to systematically verify and respond to alerts at decentralized levels. eDEWS captured syndromic definitions of disease at an aggregated level (e.g., “four cases of acute water diarrhea”), and could not produce the line-lists of patients necessary to analyze the person, place and time dimensions of an outbreak. Finally, the automatic alerting for cholera clusters was not precise enough, and the staff to carry out analysis and reporting were not trained. Upon consultation with EMRO and HQ, WHO Yemen reported no viable solution to improving the eDEWS system for cholera management.

The lapses of the surveillance system and addition of new DTCs culminated in a switch to Microsoft Excel spreadsheets at the district level. The data was compiled manually on a daily basis, with photos of logbook pages in DTCs sent via WhatsApp and SMS to the governorate MoPHP for entry into Excel. A completed spreadsheet was emailed daily to the central surveillance office in Sana’a for cleaning, compilation, and analysis by a small team. Centralizing all functions in Sana’a rendered the process slow and error-prone, resulting in a database largely stripped of outcomes (i.e., discharge/death) and long delays in cleaning and compilation. This had an immediate effect of delaying the distribution of the line-list. For example, the provenance of the week’s cases would have enabled WASH staff to target affected areas with prevention and control measures (see WASH section).

Additional epidemiology support arrived at WHO in July 2017, near the peak of the second wave. At the same time, WHO Yemen requested the support of the WHO Health Emergencies Program to implement an Early Warning Alert and Response System (EWARS).<sup>52</sup> The main goals were to better manage a large database (“Excel was at its breaking point with analyses of pivot tables of 100,000 cases” (Epidemiologist)) and to automate analyses and reports. Improving data input from DTCs and health facilities and including laboratory/RDT results and patient outcomes was also envisioned. EWARS was perceived by respondents as a constructive step that enabled rapid compilation of large amounts of data from governorates to the central

*How do you [capture] the outcomes for the patients when you have 400 patients on daily basis [for which] to link admissions with exits and [there is] a lot of missing data? [In DTCs, we] had 24 hour data coders in two shifts...*

Epidemiologist

*The epidemiological situation report was the big picture and wasn’t useful for tailoring the response; We wanted geographically smaller areas to compare, shorter periods of time.*

Anonymous

level, and automated analysis to enable real-time surveillance, data sharing, and mapping. It provided “dynamic systems for accessing and analyzing data at different levels” (Medical Officer).

EWARS had to overcome two obstacles which were slowing data processing to a halt: to provide a system for all partners to rapidly send data to Sana’a, and to ease the mounting backlog of data to be entered and outcomes (discharge/death) to be updated. However, due to the complete inaccessibility and the large-scale training needs across hundreds of DTCs, EWARS could not focus on improving data collection in DTCs. It was also configured for WHO/MoPHP’s use for the national epidemiological situation report, rather than enabling governorates and partners to access their data and localize the epidemiological curves and other indicators that could inform local prevention and control measures.

### 3.2.3. THE REQUIREMENT FOR AN EPIDEMIOLOGICAL DESCRIPTION OF MORBIDITY, MORTALITY, AND TRANSMISSION

Low data quality was a major weakness that could have been predicted and addressed after the first wave in order to have a clear impact during subsequent waves. The accurate estimation of the burden of morbidity and mortality hinged on the appropriate application of the suspect case definition (see Box).

**Suspected cholera case:** Any patient presenting 3 or more liquid stools with or without vomiting for the last 24 hours should be considered as suspected cholera case.

**Confirmed cholera case:** A suspected case for which *Vibrio cholerae* O1 or O139 is confirmed by culture.

Source: Joint Cholera Response Plan,  
Yemen, July 2017

There were several determinants of the sub-optimal application of the case definition:

- A large proportion of patients presented to the DTC to receive care for other conditions as public health care was limited elsewhere (see case management section);
- DTCs and ORCs (ORCs were present in the second wave only) may have tended to report all consultations of any patient reporting diarrhea, and not those who met the suspect case definition. Register books of all consultations were frequently used for recording cholera line-lists, documenting all consultations or persons reporting diarrhea as suspect cases. This worsened over time, with a lack of correction of the practice in the early phases, and a loss of specificity after the increasing phase of the second wave;

*We let the numbers run too high and we couldn’t show how we affected change.*

Senior UN Official

*Some districts were completely ignored...We only addressed 1<sup>st</sup> level catchment population and there are villages where we simply do not know what happened. [They are] very hard to reach. We cannot say that there are no or few community deaths.*

Health Coordinator

*The culture of [WHO and UNICEF] was to invest more in treatment and health facilities. Investing in community based intervention is low down in the line of activities.*

Health Coordinator



*My experience in Somalia was that adults are mostly [affected], and when it is endemic, it usually starts with children... In Yemen, [with] a second peak and a CFR so low, it was the right moment to change the case definition to make it more specific.*

Epidemiologist

*The case definition... was highly sensitive and poorly specific, and that's what you want. [It's better to] overcall it and safer than leaving people in the communities. This would be the same issue with any cholera outbreak you work in.*

Medical Coordinator

*After we did third party monitoring, we came out with strict case definition materials, field trainings where the case definition was agreed upon and social mobilization support to other primary care services to get all medicines and supplies. We also assured staff that we will not close DTC and will continue to get incentives even if they report no cases.*

Senior Official, UNICEF

- Health workers in DTCs had not been paid since 2016.<sup>56</sup> The incentive system rapidly implemented by WHO and UNICEF to pay wages of health workers may have inadvertently encouraged them to report suspected cases that did not meet the case definition, leading to more suspected cholera cases than was actually the case. By all accounts, this was not a case of paying for each case detected, but a more general push to continue payments. The magnitude of this practice is unknown;
- Outcomes of patients in DTCs were tracked poorly partly because of the volume of patients, the length of stay in facilities being short due to curfew, nocturnal travel restrictions, and the large proportion of rapidly recovering mild cases and non-cholera diarrhea;<sup>48,57</sup>
- The technical and material resources to carry out standard epidemiological investigations of the validity of data, transmission routes, high-risk groups and hotspots were not present;<sup>19</sup> and
- RDTs, despite being identified as a valuable tool for verifying the expansion of the outbreak, were not used judiciously and guidance for their use was not fit for the complex emergency context (see Laboratory sub-section below).



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Routine epidemiological investigations of cases are standard practice during an outbreak for describing transmission routes, high-risk groups, and hotspots. This information is then used to tailor the response. In Yemen, multi-disciplinary teams to carry out investigations were not part of the initial response. Investigations were ad-hoc and integrated into practice late within the second wave through RRTs. For example, a valuable WHO-led field investigation in DTCs of suspected increases in case in districts in Ibb and Hodeidah governorates was carried out in September 2017, during the second wave peak.<sup>58</sup> Despite these governorates having the historical presence of cholera in the first wave, WHO found major errors to which they offered guidance. The errors included poor application of the suspected case definition, patients treated for any diarrhea being included in the cholera line-lists, and an unclear understanding of data flow with lists being sent and compiled both at district and governorate levels. Overall, the lack of systems for systematic epidemiological investigation in the acute phase of the first and second waves hindered the ability of surveillance data to adequately inform the response through knowledge of the validity of the data, transmission routes, and hotspots. This is demonstrated through the lack of inclusion of epidemiological information to guide the response across the cholera preparedness and response plans (see Preparedness section).

The burden of cholera morbidity and mortality outside the health facilities was difficult to estimate given that there were no discernable pathways to monitor community-level cases and deaths through community-based surveillance. These indicators are useful as geographical alerts to gaps in access to care.<sup>33</sup> During large outbreaks in complex emergencies in Haiti and Zimbabwe, it has been estimated that 60% of the mortality occurred at the community level.<sup>59,60</sup> By contrast, when asked about community deaths, only one organization interviewed shared a report of a single community death that was reported to a DTC and investigated. Rural and remote communities especially lacked community-based surveillance of community mortality as a trailing indicator of lack of access for communities that could not reach the ORC or DTC.<sup>18</sup> Therefore, the reported low CFR needs to be interpreted cautiously as it includes mainly deaths from health facilities; the actual CFR is likely higher due to deaths occurring in the community that were not recorded well.

Finally, the lack of RRTs to verify new outbreaks and routines of transmission using epidemiological investigation and laboratory testing until late in the second wave was a missed opportunity to use laboratory resources more sparingly and make investigations as precise as possible. Such multi-disciplinary RRTs were a major focus of the Haiti cholera response to provide real-time monitoring, verification and rapid response in a difficult context.<sup>26</sup> Formalized WASH and health RRTs were implemented after the peak of the second wave (see Coordination section).

### 3.2.4. CHANGE THE CASE DEFINITION OR CHANGE THE WAY REMOTE MONITORING WAS IMPLEMENTED?

In any cholera outbreak, surveillance is characterized by overreporting due to the sensitive case definition and high incidence of other diarrheal diseases. There is no straightforward answer to addressing this complex set of technical, operational, and motivational issues that determine adherence to the case definition. The globally-accepted case definition for suspected cholera is intentionally sensitive and weakly specific to detect and treat as many cases as possible.<sup>61,62</sup> Changing the case definition would not have addressed the operational and motivation issues as training, supervision, and monitoring were still difficult to impact in the constrained context.

Respondents had mixed perspectives on whether the case definition for suspected cholera should have been revised to be more specific as the epidemic evolved over time. Most respondents believed it was best to keep the highly-sensitive case definition to detect and treat as many people with diarrhea as possible regardless if it was cholera or not, while accepting that the effects on surveillance mattered less than assuring treatment. One respondent was concerned that from the beginning of the outbreak, over-diagnosing resulted in misallocating resources like antibiotics and IV fluids of false positives to the surveillance data, rendering the understanding of the true burden impossible, and thus not allowing real-time strategic and implementation changes to occur that reflected the actual situation on ground. Some evidence from the Haiti outbreak showed that using the WHO suspect case definition for epidemics, which includes only persons five years and over, or adding symptoms, would increase specificity.<sup>61</sup> However, this would come at the expense of reducing sensitivity, and missing small outbreaks and children.<sup>61</sup>

However, as compared to changing the case definition, the systematic application of monitoring measures could have been applied, including:

- *Routine monitoring of DTC practices* by NGOs could have focused on correct application of the case definition at the source, use of logbooks to separate all consultations from the cholera line-list, and improvement of outcome tracking. Most partners interviewed reported that they did not undertake these processes systematically, even though Yemeni clinical staff could visit the DTCs. MSF and ACF recognized these problems early on, and carried out corrective measures supported by their epidemiologists. UNICEF carried out a third party monitoring mission in October 2017 solely focused on verifying the validity of the cases;<sup>63</sup>
- *Periodic and systematic analysis of RDT-positive and culture-confirmed cases* at the DTC-level would have provided a clearer picture of cholera transmission and highlighted DTCs with data validity issues at the source. The lack of laboratory-confirmed cases could have been used to signal the end of the outbreak in an area supported by a DTC.<sup>31</sup> The poor data quality and lack of laboratory linkage obviated this option. The MoPHP guidelines did not provide a realistic means of implementing and analyzing RDT and culture results (see Laboratory sub-section below);
- *Stratified trend analysis* by age groups (<5 and 5+ years), dehydration status and severity (i.e., Plan A/B/C) could have given some insight into validity of the data at different points in time;<sup>18</sup> and
- Though not the main determinant, the incentives that were put into place to pay health workers who had not received any salary for months may have inadvertently affected surveillance. Livelihoods came to depend upon reporting cholera cases. Further analysis regarding how the policy on incentives could have been modified to avoid the over-reporting (and over treatment). For instance, UNICEF led efforts to clarify with DTC staff that DTCs would not close due to decreasing reported numbers.

*The lack of RDTs was a problem. IRC was unable to follow the national protocol well (1/10 cases tested). If RDTs were available and had positive test results, they were sent to Aden via the district health officer. The results were available at health cluster (but not reported back to the DTC).*

*We did not procure internationally because lead time was too long (4 months).*

Health Coordinator

### 3.2.5. INADEQUATE LABORATORY PROTOCOLS FOR MONITORING THE OUTBREAK

The goals and protocol for monitoring the outbreak using RDTs culture positive specimens were inadequately developed from the start of the first wave, and not improved upon to make this important process meaningful. The guidance from WHO and the GTFCC is also inadequate for extremely constrained settings.<sup>64</sup>

The response plans show the progression of the laboratory strategy:

- The December 2016 response plan stated that a large-scale distribution of “360 rapid diagnostic kits to facilitate early detection of outbreaks in remote areas that have limited access to testing facilities” was ongoing. This would cover all 333 districts;
- The February 2018 response plan states “RDTs will be performed at all DTCs and ORPs for every 10th suspected case and positive RDTs will submit samples to be sent for microbiology...the outbreak will be confirmed at any district if at least 1 sample tests positive by microbiology for *Vibrio cholerae* at a district that reported ZERO cases in the last 3 weeks” (30,305 RDTs or 28% of the intended number had been used to date); and

- The April 2018 response plan introduced a change in the protocol for surveillance wherein suspect cases must be tested with an RDT in order to make the case definition more specific.<sup>65</sup>

Accordingly, Figure 7, panels F and G show the inconsistent use of RDTs and cultures throughout the outbreak. Due to these unrealistic expectations, NGOs running DTCs did not have a clear idea of the goals of using RDTs and cultures, and how they were to be interpreted to make changes on the ground. The understanding of the usage and interpretation of these lab tests are particularly important in Yemen where the laboratory infrastructure has been severely degraded. Documentation from the health cluster gap analysis in December 2016 demonstrates a lack of meaningful interpretation of laboratory tests.<sup>66</sup> During the first wave in late 2016, culture-positivity rates of 17% among 700+ stool samples was very low, and not comparable to recent outbreaks which range upwards from 49%.<sup>31</sup> Such a result could have triggered an investigation into its causes, including a thorough review and improvement in specimen collection and laboratory processes, improving the application of the suspect cholera case definition, and carrying out small laboratory sub-studies in a few sites to understand the etiology of the diarrhea.<sup>31</sup> Several recent outbreaks where RDTs were widely used have also noted the difficulties in training on RDTs, resulting in a misreading of results.<sup>31,67</sup>

RDTs were rarely in adequate supply. At various points (e.g., increasing phase of second wave), one can see high use of RDTs and high positivity rates, but this is preceded and followed by a lack of use due to lack of availability of RDTs (Figure 7). Thus, NGOs were unable to follow the limited guidelines that were available for using RDTs and cultures to guide the response over time in different areas of the country. NGOs reported using RDTs to test a handful of severe cases per week, which biases the estimate. As is common to other complex emergencies with a degraded laboratory infrastructure, samples were difficult to transport to the only two authorized central labs in Sana'a and Aden, and maintaining their integrity through sampling and transport was a problem.<sup>31</sup> Even if one out of ten samples tested was attainable per DTC, the volume of testing at the two laboratories would have been overwhelming. The GTFCC recommendation of five samples for culturing, per week, pre-selected by a positive RDT within a selected set of sentinel facilities was more reasonable.<sup>62</sup> The unsystematic use of RDTs meant they failed to be used for monitoring the outbreak.

Second, use of the suspected case definition, without a systematic use of cultures over time, rendered monitoring the trends and forays into new districts with suspected cholera difficult. Given that RDTs cost approximately 3 USD per test, evaluating one RDT per 10 patients for one million patients would cost 300,000 USD. One respondent mentioned that the money could have been better used to rehabilitate laboratories and provide transport systems to culture stool. Indeed, for cholera outbreaks in Iraq and Papua New Guinea, resources were diverted to add additional laboratories to keep up with the demand early in the outbreak.<sup>20,31</sup> The March 2018 Response Plan details efforts to “*strengthen the central public health lab and the mentioned 6 branches to conduct microbiology testing so decentralized testing of samples will be ensured*”; despite asking respondents, it is not clear why this did not happen in the earliest stages. This aspect combined with the new requirement by the MoPHP that all suspected cholera cases must be tested with an RDT and only those with a positive test will be put on a line-list is concerning. Not only does it not make sense technically, it is expensive and does not address the lack of laboratory capacity to culture RDT positive cases. This policy was reversed in 2018.

### 3.2.6. CONCLUSIONS AND RECOMMENDATIONS

- I. Suspected Cholera Cases:** Cholera outbreaks are characterized by a considerable degree of over-reporting. In Yemen, the number of suspected cholera cases and deaths is likely significantly lower than has been reported. The estimation of the true number of suspected cholera cases is not possible based on the available data alone. Although both suspected cholera and AWD cases need to be treated, the distinction between the two phenomena needs to be made in order to target cholera transmission. Given the limited capacity of partners and the extremely challenging environment, a more accurate number of suspected and confirmed cases according to geographic location would have helped with the targeting of personnel, supplies, expertise and funds to geographic locations. This is as important for core measures like OCV campaigns that rely on the accurate targeting of vaccination to areas at-risk. Furthermore, an after-action review of the data from the first wave should have triggered a review of the application of the suspect case definition to ensure validity and consistency in the second wave.
- II. Laboratory:** Continuous monitoring of laboratory findings (especially culture) is a critical part of cholera control. The laboratory guidance in Yemen was inadequate, primarily due to a lack of a systematic method for RDT and culture use, and a predictable lack of continuous supply of materials, specimen transport and testing capacity to meet the demand. Supplies of RDT were at times inadequate, personnel were insufficiently trained and there was a lack of quality control. Laboratory refurbishment outside of the main cities to ensure there was sufficient capacity to culture for cholera did not occur, and this greatly affected the interpretation of the epidemic.

- III. Decentralization of Surveillance (and Response):** In complex humanitarian emergencies, the detection and verification of outbreaks and rapid response must be prioritized. In Yemen, EWAR was introduced, albeit late. As with coordination and response, decentralized systems, in this case RRTs, should have been implemented earlier in the outbreak to allow for decentralized investigation and early response at the community level.

Community health systems including CHW networks, hygiene promoters, and Red Cross/Crescent volunteers can access communities quickly, send early warning signals of mortality clusters, are a source of preventative information, and can refer cases to care. Such community health and WASH systems were not sufficiently used at the beginning of the outbreak, and due to lack of access and consequently lack of supervision, it is still unclear how effectively these groups were and are currently being used.

- IV. Guidance and Tools:** Standardized cholera outbreak tools including standardized line-lists, data analysis and processing plans, and data flow schematics are not available globally, and thus guidance and tools had to be developed and implemented at the country level. As noted above, there is insufficient global guidance on RDTs and their usage according to different contexts.



	<b>Recommendation</b>	<b>Lead agency and other parties</b>	<b>Yemen-specific and/or future epidemics</b>
<b>2.1</b>	<p>In a complex humanitarian emergency with a weakened public health system, a large, explosive outbreak should be anticipated.</p> <p>Early warning alert and response functions of the surveillance system should be evaluated and primed, such that the surveillance system should be able to handle outbreak detection and response. This includes detection, alert functions, routine reporting from health facilities, epidemiological investigation, and patient-level data management required to contain an expanding outbreak as quickly as possible.</p>	<b>WHO, Government</b>	Yemen-specific and future epidemics
<b>2.2</b>	<p>A data monitoring plan to improve data collection and identify challenges at the field level should be implemented jointly by partners. It should include training, job-aids, quality control procedures, and guidelines that can be widely understood at the field level.</p> <ul style="list-style-type: none"> <li>▪ The analysis plan should be revisited periodically, and adjustments made to ensure the data is scrutinized appropriately.</li> <li>▪ This could be achieved by developing an analysis plan that sub-divides cases to indicate surveillance-specific trends (e.g., by age group, severity) at sub-national levels to better understand district/governorate level trends. Detailed sub-national data would aid local responses.</li> </ul>	<b>WHO, UNICEF, Government</b>	Yemen-specific and future epidemics
<b>2.3</b>	The process to produce line-lists should be further streamlined to be useful at the district level to direct the response, as well as collated at the central level.	<b>WHO, Government(s) of Yemen, INGOs and NNGOs</b>	Yemen-specific
<b>2.4</b>	Information managers are essential for surveillance and their hiring must be prioritized in all humanitarian emergencies including large-scale epidemics to organize the massive amounts of data produced.	<b>WHO</b>	Future epidemics
<b>2.5</b>	<p>RRTs should be used to conduct epidemiological investigation to identify routes of transmission, high risk groups, and epidemiological hotspots</p> <ul style="list-style-type: none"> <li>▪ This epidemiological information can be used to influence decision-making and the strategy.</li> <li>▪ It is likely most effective at the early stages where RRTs can target small outbreaks.</li> </ul>	<b>WHO, UNICEF, Government</b>	Future epidemics
<b>2.6</b>	<p>At the earliest stage, community health systems should be mapped, trained and supervised as a community-based surveillance network.</p> <ul style="list-style-type: none"> <li>▪ The main objectives are to add to the early warning alert and response component for new outbreaks, and to monitor community mortality.</li> <li>▪ This will require roving supervisory support to transform routine treatment systems into emergency-oriented surveillance systems.</li> </ul>	<b>UNICEF, WHO, Government(s) of Yemen, INGOs and NNGOs</b>	Yemen-specific and future epidemics
<b>2.7</b>	<p>An early priority should be to increase the capacity to culture cholera through the rehabilitation of peripheral laboratories.</p> <ul style="list-style-type: none"> <li>▪ An improvement strategy for laboratory monitoring of the response should be implemented, including improvements to the capacity to transport specimens.</li> </ul>	<b>WHO, Government(s) of Yemen</b>	Yemen-specific and future epidemics
<b>2.8</b>	Given their low specificity, RDTs should not be used as a precondition for cases to be line-listed as was used in Yemen at the request of the government following the second wave. WHO has stated that the MoPHP reversed this policy in mid-2018.	<b>WHO, Government(s) of Yemen</b>	Yemen-specific
<b>2.9</b>	The data management component of the early warning alert and response surveillance system should be further developed to include at least RDT and culture findings and if attainable, real-time input from laboratories, to facilitate improved surveillance analysis.	<b>WHO HQ Health Information Management</b>	Future epidemics



### 3.3 PREPAREDNESS AND STRATEGY

This section discusses the cholera preparedness and response planning in place prior to the outbreak and between the first and second waves (April 24, 2017 to March 12, 2018).<sup>13</sup> It is informed by both the literature review of 58 Yemen-specific documents and the results of the KIIs. Figure 3 shows the critical points in time for disease occurrence, key interventions, and the release of funding. It does not however imply actions had immediate impacts on the caseload. The descriptive epidemiology of the outbreak is reviewed in the surveillance section.

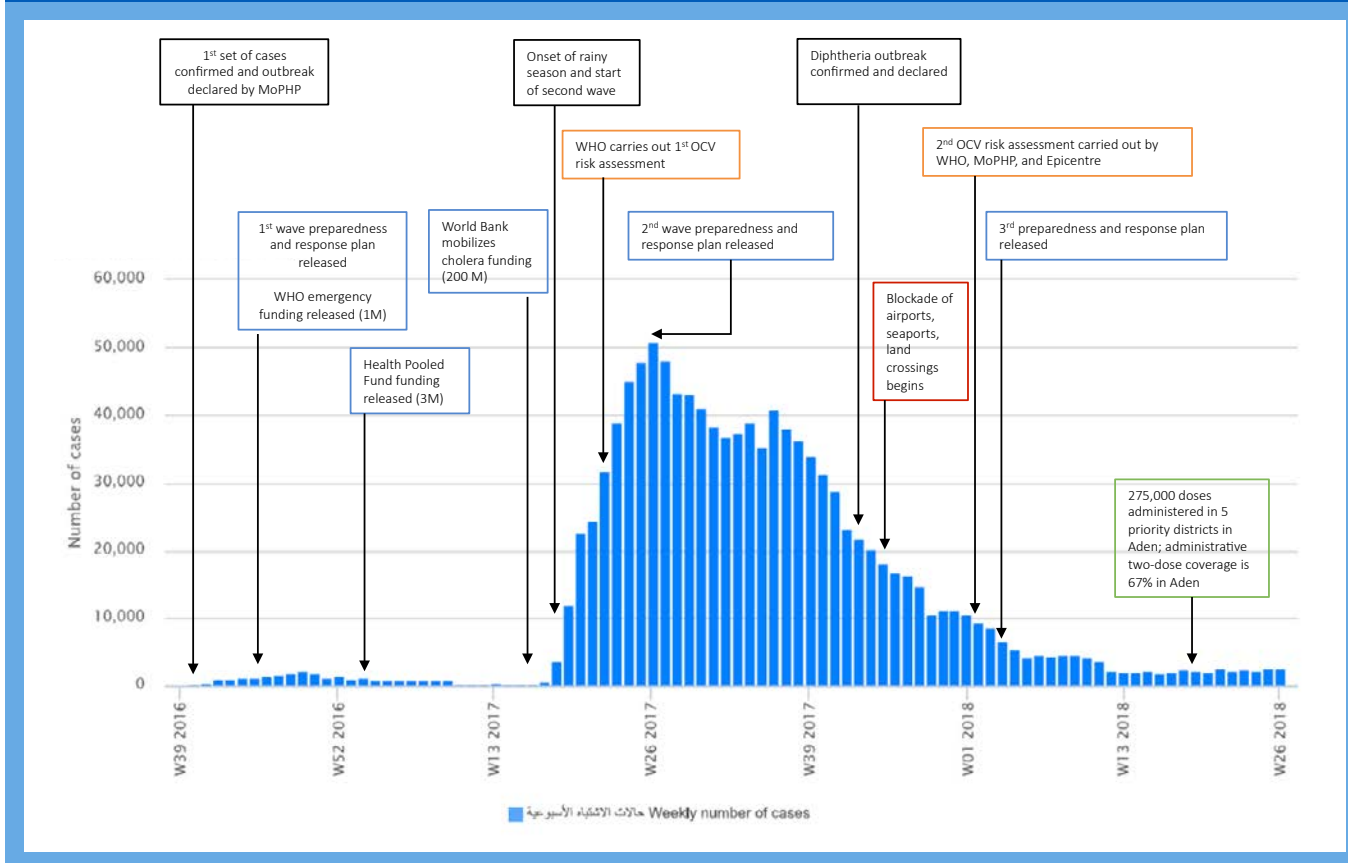
#### 3.3.1. ANALYSIS OF THE CHOLERA PREPAREDNESS AND RESPONSE PLANS

Yemen did not have a cholera preparedness and response plan before the 2016 outbreak. The WHO’s Regional Office, EMRO, made efforts to establish a regional framework for cholera prevention and control between 2014 and 2017.<sup>68-70</sup> The lack of preparedness planning meant that much of the initial response focused

on the procurement of ORS, IV fluids, and other critical supplies. According to the head of a major agency: “*The response to the first wave was late, and the materials requested from first wave arrived when the second wave was starting*”. Upon declaration of the cholera outbreak in October 2016, the health and WASH clusters and the MoPHP developed an integrated cholera preparedness and response plan within one week. Plans for the first and second waves were developed iteratively throughout the outbreak. The key features of the plans are shown in Annex 3.

The first preparedness and response plan in October 2016 was developed as transmission was increasing, and thus focused on developing systems for response and prevention. The second version of the plan was issued in November 2016. Both versions emphasized blanket approaches at the governorate level where cholera had been confirmed or was likely to erupt due to suspected cases accumulating or the presence of risk factors (an area covering 7.6M population). This included improvement of water and sanitation systems; establishment of diarrhea treatment centers

**Figure 3: Timeline of key events of the cholera outbreak, 2016-present**



(DTCs); strengthening the existing system of integrated community case management (iCCM) for diarrhea; and RDTs as essential for extending laboratory services to remote areas. WASH components remained general, including blanket distribution to generalized high-risk areas (where confirmed or suspect cases were documented) rather than targeted interventions to cholera-affected households and communities. The November plan referenced the *Sword and Shield Strategy* used in West Africa to carry out control activities in affected areas and prevention activities in non-affected areas simultaneously.<sup>71</sup> In this version, a National Cholera Task Force (CTF) and sub-national CTFs were mentioned. However, all versions lacked reference to case definitions, laboratory protocols, ORCs, strengthening of peripheral laboratories, community surveillance, OCV, and in general, a workplan and geographical targeting of the interventions. Without more specific geographical targeting and a clear workplan, the plan remained ambitious in scope.

The third version of the cholera preparedness and response plan was issued in July 2017 during the second wave at a point when cholera transmission had peaked. It focused on improving existing systems for the second wave. This version of the plan was well-developed, but appeared too late to provide systematic preparedness and early response for the second wave. The population at-risk was large (26M) and there was a clear emphasis

on control in 286 (out of 331) districts and prevention activities in fewer districts (47). Case definitions were outlined and the numbers of DTCs and ORCs that were functional were given. Coordination was intended to be more decentralized, and the plan to establish an incident management system (IMS) and emergency operations centers (EOCs) across governorates was described. IMS were linked to health (but not WASH) RRTs, which were to support investigation and early response at the district levels. Important gaps included the laboratory protocol, reestablishment of peripheral laboratories, and plans for monitoring DTCs and ORCs in real-time. Risk assessments for OCV are mentioned for both reactive and preventative use.

The fourth version of the preparedness and response plan for the anticipated surges in cholera was issued in February 2018 and focused on some of the key gaps (i.e., systematic approach for RDTs; network plan for DTCs and ORCs; outline of the relationships between clusters, IMS, and CTF; establishment of decentralized RRTs for investigation and response; community volunteer mobilization) and elaborated on an operational plan for the preventative use of OCV. The plan had inputs from the nutrition cluster on severe acute malnutrition (SAM) and infant and young child feeding (IYCF). It advocated to ensure timely and appropriate referrals between ORCs/DTCs and the therapeutic feeding centers, outpatient and targeted supplementary feeding programs. However, improvements in the ability to culture cholera and surveillance were not described. Infection prevention and control (IPC) in DTCs and health facilities was to be managed by health actors, with WASH involved if health actors requested assistance. Finally, both the iCCM and community surveillance approaches mentioned briefly in the first version of the plan had not been implemented by this time.

*The small [first] wave should have put in place alerts, and people to answer to the second wave. We need to analyze why the second wave was so big, even with rainy season (it's a factor), but why was it so massive.*

Epidemiologist, present during the first wave

*With cholera, we need money as early as possible to see any effects [of interventions].*

Anonymous

### 3.3.2. GAPS IN CHOLERA PREPAREDNESS AND RESPONSE PLANS

There are common omissions across the four versions of the plan. The most important is the lack of use of epidemiological information to inform the response in terms of routes of transmission, groups at-risk, and epidemiological hotspots. This type of detailed analysis guided the selection and location of interventions in other national plans, such as South Sudan's 2017 plan.<sup>72</sup> In addition, the four versions of the plan have other common omissions:

- Extending the laboratory network by rehabilitating laboratories in peripheral areas;
- Descriptions of how surveillance outside of health facilities should be achieved (e.g., community-based surveillance and early warning systems);
- Descriptions of standard operating procedures and guidelines for the real-time monitoring of the response;
- Systems to monitor the appropriate application of the case definitions;
- Systems to monitor the quality of care and IPC in DTCs and ORCs;
- Plans to adapt the network of DTCs and ORCs according to the epidemiological situation; and,
- Systems for epidemiological investigation of modes of transmission.

The lack of a stated emphasis on the systematic use of laboratory culture results, epidemiological investigation, and monitoring meant there was no way to investigate and address the high proportion of mild cases and possibly non-cholera cases being reported. In turn, extensive human resources, logistics, and surveillance efforts were applied to sustain the response for such a large geographical area.

### 3.3.3. PREPAREDNESS PLANNING FOR THE ANTICIPATED ENDEMICITY OF CHOLERA

A respondent specified that if only the cholera response plan was more institutionalized in the first wave, and lessons were applied forward, the second wave could have been better controlled. One respondent criticized the lack of essential preparedness components in the February 2018 cholera preparedness and response plan. Critical areas are missing, including:

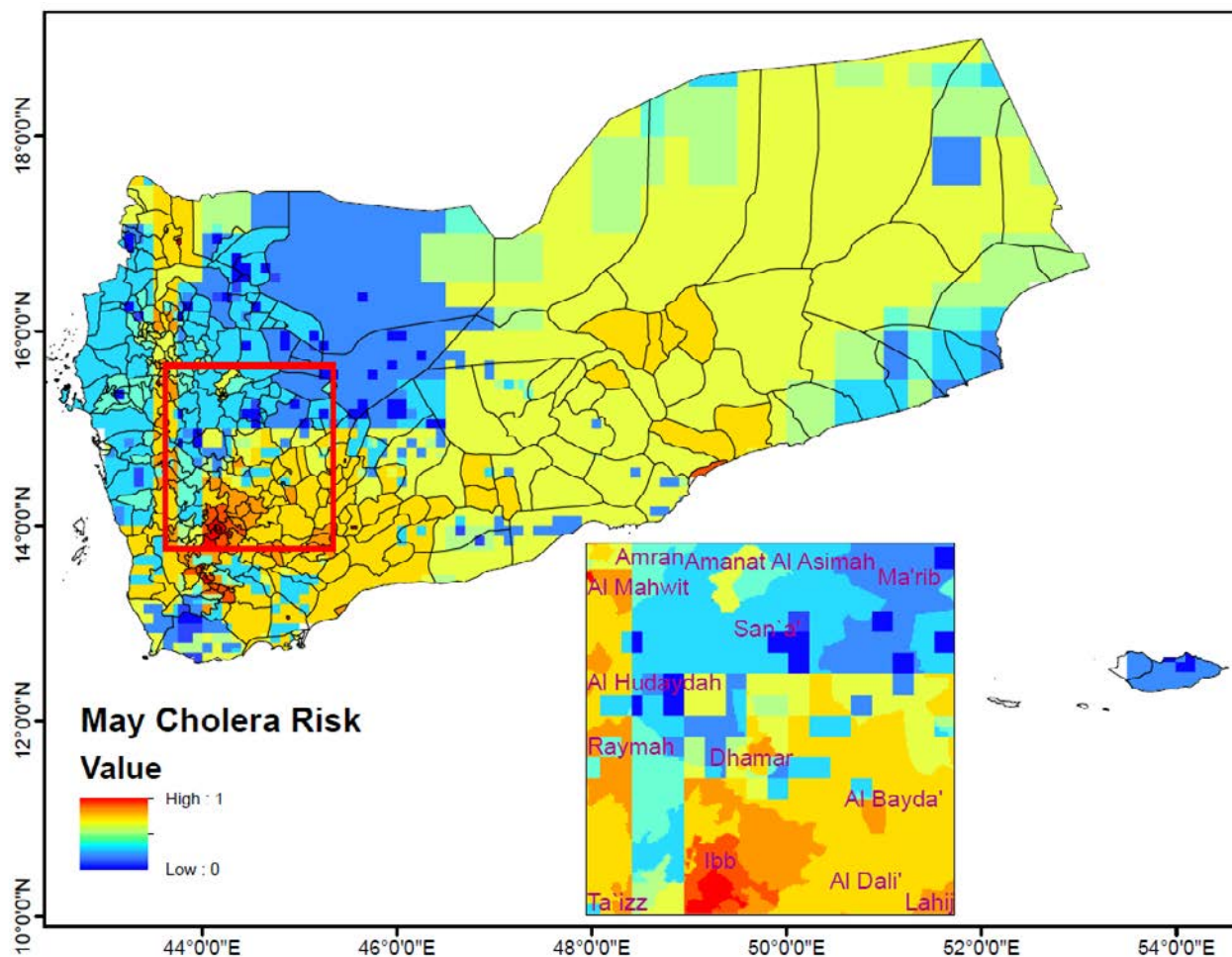
- The planning assumptions including number of cases;
- Scale and location of health and WASH response anticipated;
- Risk assessment for cholera incidence and geographical hotspots (apart from the OCV risk assessment)
- Specific roles of agencies; and
- Financial arrangements for rapid intervention and an anticipated budget.

There was another view presented stating that discussions and planning for OCV deployment exhausted the discussions around other preparedness measures. According to one respondent: *“Conversations on OCV and preparedness planning were treated as separate things. We should have talked about the overall plan for the next rainy season and what to do for it.”* On the other hand, several aspects of the response infrastructure were built up over time, which reinforces preparedness. This includes, health and WASH RRTs, decommissioning and rapid recommissioning procedures for DTCs, and OCV campaigns in high-risk districts.

To further the identification of cholera risk and potential hotspots in a timely manner, UNICEF has begun using climate modeling carried out by the UK Meteorological Office and the West Virginia University to use rainfall together with risk factors to perform a weekly prediction of risk of cholera incidence by geographical area (Fig 4).<sup>73</sup> This provides a prediction of cholera infection risk three to four weeks in advance. In 2017, the model was 92% accurate in forecasting the geographical areas where cholera was most likely to occur including inland areas that were previously not susceptible to outbreaks.<sup>74</sup>

Figure 3: Preparedness modeling, May 2018

## Cholera outlook for Yemen-May 2018



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This research work is "in progress" and results should be interpreted carefully and cautiously. Work is made possible through a research grant from the NASA Applied Sciences Program.

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UNICEF is using the climate modeling to prioritize geographical areas for prevention and case management activities.<sup>75</sup> Evaluation of the efforts and impacts of this forecasting in Yemen will be useful for preparedness for potential future outbreaks.



### 3.3.4. FUNDING FOR THE RESPONSE

Seventy-four percent of the USD 2.39 billion requested in Yemen in 2017 was funded to support the overall humanitarian response.<sup>76</sup> The amount of funding and the speed of its release was not cited by respondents as a challenge. For the first wave, a gap analysis was undertaken in late 2016 to assess the immediate needs for cholera response. Funding was provided by the Central Emergency Response Fund (CERF), Health Pooled Fund, and WHO contingency funds. In the second wave, humanitarian donors including OFDA, DFID, and ECHO provided funding, alongside various governments.

It is of note that the World Bank and the UN have formally committed to cooperate closely to address populations affected by violent conflict and protracted humanitarian crises.<sup>77</sup> During the second wave, the World Bank resumed funding in response to pre-famine conditions and cholera through a recommitment of cancelled International Development Association grants via the Crisis Response Window. WHO Yemen believed it was able to respond in a timely manner for the second wave due to the World Bank's through co-funding the Emergency Health and Nutrition Project for WHO and UNICEF. The World Bank immediately released USD 10 million within days of onset in February 2017, and WHO used additional WHO contingency funds to organize the procurement and delivery of cholera kits within one week. Overall, the World Bank gave USD 483 million to target the preservation of basic health and nutrition services at the governorate level, and systems for cholera control including surveillance, training of staff, district health operations. This initiated the payment of health care worker incentives. Based on an analysis of needs for national cholera outbreaks in Haiti and Africa, the World Bank provided USD 200 million (Feb 2017), split between UNICEF (WASH and primary health care) and WHO (health and secondary health care), and another USD 83 million (Mar/Apr 2017). The World Bank used a contingency emergency response component to mobilize USD 45 to 50 million from prior funding for reimbursement at a later date. This ensured that other services continued to be covered as cholera was being addressed. Finally, an unintended and positive consequence was that the joint funding ensured WHO and UNICEF worked closely together to effect changes on the ground (see sidebar).

### 3.3.5. MONITORING THE RESPONSE

Rigorous monitoring of programming in constrained environments like Syria, Somalia, and Yemen, is inherently difficult, and is considered a blind spot for humanitarian health assistance. This was the rationale behind the Global Health Cluster's development of practical guidance on remote programming and monitoring.<sup>34</sup> A remote management setting requires strong systems for external verification including third party monitoring (TPM) of program outputs; quality assurance of program delivery (including a means of rapidly addressing quality of care and IPC in

*The World Bank project made WHO and UNICEF work together. We met every day. [We were] one team, joining forces.*

Senior WHO staff

*The World Bank made an investment for future, for when they can get back in-country. They showed they were willing to take a gamble. You'll see them in more places with de facto governments to build an operational footprint.*

Senior UN official

*If we support an organization to run clinics...there is the concern we don't know what's going on. There are a lot of DTCs and ORCs and we are hopeful they are doing it correctly and they are operational. We need NGO staff to go into facilities to pull data and check operations.*

Donor

health facilities); and options for the remote training/mentoring of health staff.<sup>34</sup> The cholera response and preparedness plans for the first wave describe the monitoring indicators, but do not describe the challenges in execution of a remote monitoring approach. In inaccessible settings (i.e., outside of Aden and Sana'a), such a plan could have been outlined, including a means of funding the remote monitoring.

Different monitoring approaches were taken by organizations. The health cluster produced standard checklists and guidance for collecting core data at DTCs and ORCs on a frequent basis (Annex 4). IMC and YRCS had officers based at decentralized sites to do regular monitoring and reporting. In areas that UNICEF could not access, it relied on TPM by an external agency to visit DTCs and ORCs once a month (and weekly, at the peak). WHO used similar TPM. UNICEF TPM reports detailed information on stockouts of supplies, functionality of the facilities, etc. In addition, TPM monitors carried out more detailed assessments of adherence to the case definition at the facility level. However, a UNICEF internal evaluation of the Yemen cholera outbreak highlights that TPM does not substitute for direct program oversight, and that the link between TPM, internal review, and decision-making were not as strong as was needed within UNICEF.<sup>49</sup> On a more routine basis, the systematic use of community health volunteers (CHV) or community health workers (CHW) to record ORC data using mobile phones on volume, care delivered, and demographics in remote and insecure settings may have been helpful in better monitoring the burden of disease and the operations of ORCs and DTCs in real-time, as was employed during the 2016 Somaliland outbreak.<sup>30,78</sup>



### 3.4. CASE MANAGEMENT AND HEALTH

Case management is a priority intervention the health sector must support to ensure that individuals can promptly access care and receive treatment, to minimize their risks of severe dehydration and death, and to reduce community transmission through isolation of patients. Most persons infected with *V. cholerae* do not display symptoms, and the majority of those who are symptomatic have mild or moderate symptoms that can be treated with ORS.<sup>79</sup> About 20% of symptomatic cases are severe and require IV rehydration and antibiotics.<sup>79</sup> With access to appropriate treatment, the CFR in a cholera treatment facility will remain below 1% (within cholera treatment centers only, not in communities); however, without prompt access to care, patients with severe cholera can die of hypovolemic shock within hours of symptom onset.<sup>1</sup> Effective case management involves three levels of care:

- a. Oral rehydration points (ORPs): Referred to as oral rehydration corners (ORCs) in Yemen, ORPs are decentralized points of care ideally located within communities. They are typically open during daylight hours and staffed by nurses and/or CHWs who are trained to assess a patient's level of dehydration. Patients with mild or moderate levels of dehydration are treated with ORS (and zinc for children), and those with severe dehydration are referred to the cholera treatment unit or center.
- b. Cholera treatment units (CTUs): are fixed, small treatment centers that may be attached to an existing health facility. They are open around the clock and have an inpatient capacity typically between 5 to 40 patients. CTUs are staffed with doctors, nurses, and WASH staff, and can treat cholera patients suffering from mild to severe dehydration through the provision of oral and IV rehydration.
- c. Cholera treatment centers (CTCs): These dedicated cholera treatment facilities are larger and located closer to population centers than CTUs. They are open around the clock and typically have an inpatient bed capacity of 40 to 200 patients. CTCs are staffed with doctors, nurses, WASH, and support staff, and can treat cholera patients suffering from mild to severe

dehydration with oral and intravenous (IV) rehydration. In addition, staff are able to manage patients with complications and co-morbidities.<sup>79</sup>

In the Yemen cholera response, there was no differentiation between CTUs and CTCs; all in-patient treatment facilities in Yemen were called diarrhea treatment centers (DTCs) regardless of bed and treatment capacity.

### **3.4.1. THE TREATMENT NETWORK FOR SUSPECTED CHOLERA CASES WAS INSUFFICIENTLY DECENTRALIZED AND DID NOT ENSURE ADEQUATE ACCESS FOR THE ENTIRE POPULATION**

The decision to place most DTCs within or close to pre-existing health facilities made the triage of mild and moderately dehydrated patients ineffective. For both waves, the strategy focused on establishing DTCs and ORCs in or near existing health facilities, typically covering only the first zone within a district, rather than being driven by placement near areas of need.

To better understand the gap, the classification of catchment areas can be described. Catchment areas are divided into three zones per district to facilitate the immunization program. The first zone covers the population that can access the health facility by foot (typically, population-dense urban/peri-urban areas); the second zone is the area where outreach by healthcare workers is required; the third zone is the area farthest from the health facility wherein health workers require vehicles to reach the population.<sup>80</sup> According to a respondent involved in planning, DTCs were usually located in or near health facilities in the first zone. The motive for this centralization, often decided upon by the governorate or district health authorities, was to strengthen existing health facilities, rather than build temporary structures closer to the affected communities. Of note, more than 1,900 (54%) of the 3,507 health facilities were non-functional or partially functioning due to years of war.<sup>7</sup> Respondents could not sufficiently elucidate further the treatment pathway for cases outside the first zone, because most were not able to visit due to security. It is unclear if these patients had sufficient access to treatment, and if not, how they received care or entered the surveillance system.

*The response from the big players has been to build up treatment capacity, and neglect community-based efforts. This is of limited value in addressing the outbreak at the source.*

Health Coordinator

*Community health workers were involved in the hotspot districts. I mean, a lesson learned could be that we should have used them more.*

Health Team, UNICEF

ORCs provide access to oral rehydration therapy (ORT) at the community-level and as such, should be the first point of contact for patient care. Although ORCs as treatment facilities for diarrhea are common in many contexts in Sub-Saharan Africa, in Yemen, ORCs were only established after the start of the second wave of cholera in April 2017. In the July 2017 preparedness and response plan, UNICEF recommended a minimum of five to eight ORCs per DTC. While this ratio appears reasonable given the high numbers of mild and moderate cases, the locations of the ORCs did not address the epidemiological picture. In Yemen, ORCs were established within existing health facilities as opposed to being decentralized and located in the community, as has been the strategy in other settings like Haiti and Somaliland where a large number of cases can be quickly and effectively treated.<sup>50,78</sup> This inadequate geographic coverage of functioning ORCs combined with DTCs located in zone 1 areas likely excluded certain portions of the population from accessing care in a timely fashion.

Transportation of patients requiring referral from ORCs to DTCs was also consistently identified as a barrier by respondents. Many patients could not afford the cost of transportation, and transportation or reimbursements were not provided to patients by partners. Patients had to potentially walk more than one hour from the ORC to a DTC, according to some respondents. One respondent discussed current efforts to utilize funding to cover the cost of patient transport.

Camacho et al. demonstrated that only 32.4% of suspect cholera cases in Yemen visited a DTC on the same day of symptom onset and for 10.2% of patients it took two or more days to access care; however, patients should be able to access an ORC within one hour of walking.<sup>13,81</sup> The high proportion of mild and moderately dehydrated patients should have received ORT at an ORC closer to their residence, therefore providing more timely treatment as well as reducing the burden at DTCs. Using the most recent information available from the Yemen health cluster on location of cholera treatment facilities, we created a governorate level map (Fig 5) showing the ratio of functional ORCs to DTCs. While we are unable to verify if these facilities are truly functioning nor whether the number of facilities that were provided to us is cumulative and not cross-sectional, the number of ORCs as compared to DTCs appears insufficient in the majority of governorates. If it is deemed necessary that an area needs one DTC to serve its population, knowing that there are typically far more mild and moderate cases than severe, it follows that an appropriate response requires far more ORCs than DTCs. In the case of Yemen, UNICEF and WHO recommended 5 to 8 ORCs for each in-

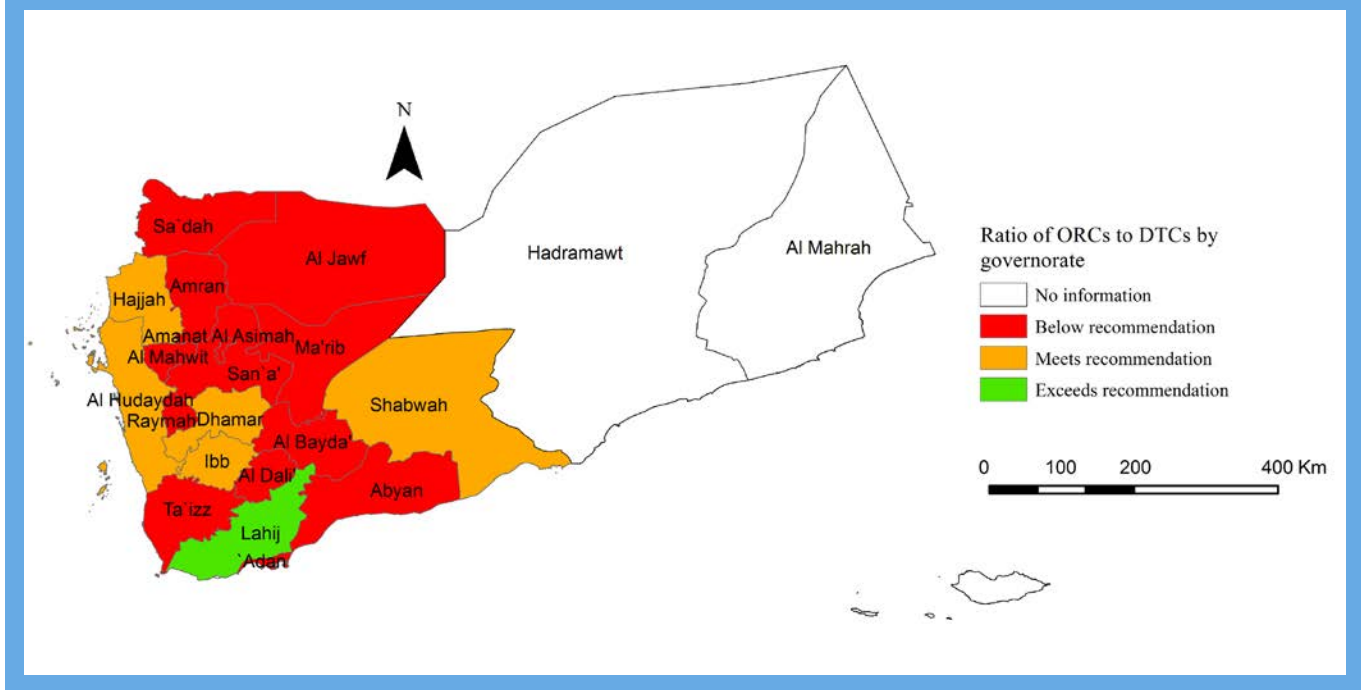
*DTCs [could] not be set up at the community level. We advised partners to be close and link or attach to an existing health facility...in an isolated place in the hospital to use as a DTC. [This was for facilitating] lab and access to advanced medical care.*

Anonymous

patient treatment facility. This did not occur in 65% of governorates, likely resulting in poor access for the population.

Respondents called the response “*treatment-focused*” and of limited value in being “*unable to address the outbreak at the source*”. At the same time, the feasibility of carrying out a fully decentralized community-focused response seemed questionable given the ongoing conflict.

**Figure 5: Ratio of ORCs to DTCs during the second wave, April 24, 2017 – March 12, 2018**



Notes: The intended ratio was 5 to 8 ORCs per DTC; data sourced from Health Cluster list of DTCs and ORCs, current as of June 2, 2018<sup>82</sup> and Camacho et al., 2018.<sup>13</sup>

### 3.4.2. THE APPROACH AND INFRASTRUCTURE FOR TREATMENT FACILITIES RESULTED IN CHALLENGES MAINTAINING INFECTION PREVENTION AND CONTROL STANDARDS AND LIKELY CAUSED DISRUPTION TO PRIMARY HEALTH CARE SERVICES

Decision-making regarding the physical infrastructure and location and for DTCs was driven by the overall humanitarian need to integrate services due to a limited number of facilities and health care personnel, which caused tension with the standard recommendation to treat cholera in isolated centers. The approach taken was to co-locate health services, including primary health care, nutrition, and cholera, in a single complex. This strategy intended to make the best use of the limited funding, human and physical resources, and WASH infrastructure to address health and nutrition needs. UNICEF also reported supplementing this approach with a gap analysis done at the governorate and district levels based on epidemiological needs to determine the placement of DTCs in the country. Physical spaces for DTCs included schools and health facilities, neither of which were ideal as they displace routine services offered in these spaces and pose considerable challenges to maintaining IPC standards. This division of an existing structure does not allow for adequate patient flow to ensure the IPC practices that are fundamental to a CTC. For these reasons, WHO and UNICEF advocated for DTCs to be located in temporary structures such as in tents but were often over-ruled by governorate and district health authorities. It should be noted that some partners like MSF were able to build temporary facilities. This meant that the existing or refurbished health structure was divided into a DTC and a health facility to treat all other needs.

It was Save the Children's experience that co-location was disruptive to reproductive health services. One health advisor reported that on a recent visit to a health facility, the rooms that were previously designated as the "DTC area" were no longer being used for cholera treatment, but also remained closed for other service provision, disrupting reproductive health service and forcing delivery with inadequate privacy. Furthermore, there are no data available to assess how the non-DTC part of the health center functioned and if there were sufficient health care personnel and supplies to treat cholera. As was seen in some areas during the Ebola outbreak in West Africa, there exists the possibility that patients who had other conditions may have received little or no care.

Partners running DTCs were challenged by how to manage non-cholera diarrhea and other conditions. The Yemen DTC standard operating procedures (SOP) indicated that patients diagnosed with a non-cholera condition should go to the 'normal dispensary' for treatment but did not elaborate on how to achieve this.<sup>83</sup> This is unrealistic in a country where less than 50% of health facilities were functional and the already limited human resources for health were being consumed by the cholera response. Since some DTCs were often the only source of healthcare, patients may have sought other treatments at the DTC, and were recorded as suspected cholera cases.<sup>58</sup> As well, DTCs in the second wave were appropriately providing hygiene kits for persons with suspected cholera, potentially placing pressure on both patients to state symptoms that met the cholera case definition, and on health care workers to admit patients to DTCs.

A health sector leader reported that there was no comprehensive list of DTCs and ORCs from the first wave available for reactivation in the second wave. Upon investigation at the start of the second wave it was found that many DTCs were dysfunctional as they were occupied by displaced persons, looted of supplies, or being run as private businesses. Therefore, reactivation of DTCs for the second wave was less timely and efficient. In response, in October 2017 the health cluster, MoPHP, and WHO, released draft guidance to guide the decommissioning of DTCs and provide standards for rapid reactivation.<sup>84</sup> The guidance relies on laboratory and epidemiological data to determine downsizing and closure, and states that all closed DTCs must retain the ability to re-open in less than 24 hours with supplies prepositioned. In addition, it states that only stand-alone ORCs should be considered for closure, while ORCs that are part of an existing health facility should remain open year-round to provide treatment of diarrhea.<sup>84</sup> This guidance on decommissioning, coupled with an accurate listing and mapping of DTCs and ORCs, are important documents in guiding a timely and effective response in the event of surges in cholera.



### 3.4.3. CASE MANAGEMENT GUIDANCE WAS DELAYED AND INCONSISTENT

Adapted technical guidance on case management were provided with substantial delay, which is significant given the complex and unique context. SOPs from CTF/MoPHP/WHO for DTCs and ORCs were not published until the end of May 2017, after the start of the second wave. Operational partners instead relied on various guidelines including the 2004/2017 (draft) MSF cholera guidelines and the Tanzania 2016 cholera guidelines. While the various clinical guidelines are similar, the lack of operational guidance and standards is significant given the risk factors and operational challenges posed by the complex emergency environment. This includes:

- Severe food insecurity and SAM (e.g., feeding patients; managing SAM-cholera com-morbidity);
- Inadequate water and sanitation (e.g., WASH standards for setting up DTCs);
- Widespread conflict (e.g., standards for providing sufficient access to ORCs and DTCs);
- Requirement for remote management, supervision and monitoring of DTCs and ORCs;
- Extremely constrained laboratory and surveillance systems (i.e., modified protocols for stool collection, RDT use, and culture use); and
- Management of health and public sector workers who had not received salaries since 2016.<sup>56</sup>

Core guidance was needed. As part of comprehensive case management and good IPC practice, provision of food for patients and caregivers in DTCs is best practice, and especially important in a food insecure context, however many partners were not routinely providing food in DTCs.<sup>79</sup> After the guidance was available, inconsistencies in the use of IV fluids and antibiotics persisted. Adult patients reportedly made demands for IV fluids, even when they were not indicated, resulting in overuse. GTFCC, WHO, and MSF guidelines make clear that ORS is effective in treating mild and moderate levels of dehydration due to cholera, and only those patients who are severely dehydrated require additional IV fluids.<sup>33,85</sup> Although ORS is a well-known and widely accepted treatment for children with diarrhea in Yemen due to the use of the Integrated Management of Childhood Illness (IMCI) approach, ORS was not an established treatment for adults with diarrhea prior to cholera, and therefore was not readily accepted as treatment during the outbreak. While this phenomenon is not uncommon in cholera outbreaks, it was particularly problematic in a context like Yemen where human resources and supplies were extremely limited. Appropriate utilization of ORCs could have offset the burden on DTC staff and resources, and reduced the risk of violence that is inherent with travel in a conflict zone.

Antibiotics were also used inconsistently. Aligned with GTFCC and MSF recommendations, the Yemen MoPHP SOPs published in May 2017 indicate that only severely dehydrated patients (treatment plan C) should receive antibiotics.<sup>33,79</sup> There is evidence to support the use of antibiotics as an adjunct to rehydration therapy in cholera patients with severe dehydration; it can reduce the duration of diarrhea by a day and a half, decrease the volume of stool by up to 50%, reduce the amount of rehydration fluids required by 40%, and lessen the length of shedding of *V. cholerae* by about three days.<sup>86</sup> Despite clear evidence-based guidance for the Yemen response, multiple respondents indicated that the DTCs they ran administered antibiotics to moderately dehydrated patients as well. One partner identified the problem of over-prescribing antibiotics as a result of local providers failing to follow protocols. With increasing concerns of antibiotic resistance, inappropriate prescription and misuse of antibiotics highlights the needs for direct monitoring and provision of supportive supervision in the DTCs.

There was a lack of consideration of technical guidance for the treatment of cholera among high-risk and vulnerable groups including pregnant women and children with SAM (the latter is discussed in the nutrition section). Given the size of these populations, such omissions are significant. During the national cholera outbreak in Haiti, the proportions of fetal deaths ranged from 8% to 16% among infected pregnant women, highlighting the need for specialized treatment protocols.<sup>87,88</sup> A 2015 systematic review found a proportion of fetal deaths of 7.9% among 737 pregnant women with cholera from 1991 to 2013.<sup>89</sup> These studies suggest the severity of maternal dehydration is a major risk factor associated with fetal death, but there is no guidance on alternative treatment protocols endorsed by WHO or the GTFCC. Partners identified this continued lack of guidance as problematic in Yemen. Although MSF has drafted guidance on cholera case management for pregnant women and had shared this guidance with the health cluster, one partner reports s/he was told not to use these protocols by the health cluster as they were not evidence-based but was not given alternative guidance. This is likely due to the evaluation of this, or a similar MSF protocol (aggressive rehydration and treatment in a specialized CTC), which did not demonstrate a reduction in fetal death, though it did show trends possibly reflecting improved outcomes.<sup>87</sup> This partner reported difficulties among staff to determining how to manage these patients and “a noticeable number of maternal and intrauterine deaths” in their DTCs. There was no data provided to the study team to investigate this further, however, the GTFCC is aware of this gap in treatment protocols and has identified treatment of cholera in pregnant women as a priority area for research.<sup>90</sup>

#### 3.4.4. THE QUALITY OF CASE MANAGEMENT WAS DIFFICULT TO MONITOR

Ongoing conflict and insecurity severely limited the ability of international and national staff to travel within Yemen. Partners interviewed (e.g., IRC, IMC, MSF) had few or no expatriate health staff directly working or supervising work in the ORCs and DTCs. Site visits were difficult to arrange, inhibiting direct supportive supervision from experienced personnel. In addition, national staff who worked in ORCs and DTCs had difficulties travelling to Aden and Sana’a for face-to-face meetings and trainings. As a result, there was a lack of visibility and quality control for care occurring at ORCs and very limited supervision in DTCs. The same issues existed for the UN agencies. During the interviews, several respondents began by stating what should be happening in treatment facilities, but were unable to corroborate facility activities as they had limited ability to visit the facilities themselves. This is particularly true of the more remote and insecure districts in Yemen.

One partner stated that treatment centers “clearly had quality issues”, and many acknowledged that program monitoring was difficult. However, beyond the use of national staff to conduct routine site visits and collect data when possible, few discussed strategies to ensure that quality case management was occurring. One partner did discuss the utility of the DTC/ORC evaluation checklists issued by the health cluster. These are considered standard and can be found across guidelines. The respondent stated that using the checklist allowed for a more systematic methodology of evaluation by national staff, increased accountability, and allowed for the creation of action plans to improve clinical care. UNICEF used third party monitoring to systematically monitor DTCs and ORCs. Beyond this, the interviews did not indicate that other organizations considered hiring local organizations to provide supervision and monitoring or if any mobile or telemedicine technologies were attempted to improve case management and monitoring.

### 3.4.5. CONCLUSIONS AND RECOMMENDATIONS:

- I) Decentralize care:** Decentralized and community-based care is especially important in the Yemen context where less than 50% of health facilities are functional due to the conflict, much of the population lives in rural and remote areas, and the movement of the population is limited due to insecurity.<sup>81</sup> Adequate community level ORCs staffed with CHVs could effectively manage patients with mild and moderate cases of dehydration (typically 80% of all symptomatic suspected cholera cases)<sup>91</sup> in a more timely manner, unburden DTCs, refer and provide transport for patients when indicated, and provide real-time information on the progress of the outbreak in remote locations. Crucially, the location of ORCs as well as DTCs should be distributed in the second and third zones so that patients do not have to travel more than one hour by foot to access care. While there are serious security challenges to decentralization, the RRTs show that it is possible together with increased reliance on NNGOs.
- II) Referral and transportation:** GTFCC guidance emphasizes that transportation or subsidies to cover the cost of transport should be provided to reduce the time it takes patients to access care and transfer patients between facilities. This transport system does not need to be an ambulance per se, but could be a dedicated vehicle, bicycle, or animal. Vehicles must be properly disinfected and prevention education must be provided to drivers.<sup>81</sup>
- III) Establishment of DTCs:** As per guidelines, DTCs should be set up in temporary structures adjacent to existing health facilities so as to allow for: immediate access by the population; the continuation of routine health service delivery including primary care and sexual and reproductive health; appropriate IPC; and concentration of the limited human resources.
- IV) Treatment facilities, and monitoring:** An up to date list that catalogues location, number of beds, staffing, and materials needs to be maintained by the health cluster. In addition, a database of treatment facility assessment dates and scores utilizing a standard evaluation checklist including functionality, training, supervision, and stock needs would be a valuable for planning and preparedness measure. District-level ORCs could provide effective treatment for the high levels of AWD that exist in Yemen as well

as serve as an early alert for a resurgence of cholera in the future. Partners report that despite health cluster guidance to maintain ORCs as part of the primary health care minimum service package, many are currently closed as they were seen as “*part of the cholera response*.”

- V) Treatment:** There should be an emphasis on ORT as an effective treatment for AWD in adults as well as children. This messaging should be included in information, education, and communication (IEC) materials. Furthermore, improved supervision at all levels to ensure the existing guidelines regarding ORS use are followed should occur. If these are followed, there will be a consequent reduction in the use of IVs and antibiotics, which will free up time for health care workers to allow them to prioritise their care to the more severe cases as well as save money. There are several important issues that still need to be resolved on case management of suspected cholera in Yemen. Immediate priorities should include creation of guidance on treatment of pregnant women with cholera.
- VI) Supervision and quality of care monitoring:** There has been a lack of supervision by the UN and INGOs of case management in many facilities for a variety of reasons including extreme insecurity and thus lack of access, and limited number of experts allowed in the country. This lack of access to health facilities has prevented quality monitoring and real-time, on-site supportive supervision and training. There is clearly no easy recommendation to practically improve the situation, however accountability must be considered. Despite being sporadic, communication via internet and telephone networks is possible. WASH and health have RRTs and CHV networks that, although late in the cholera response, are functioning. Furthermore, UNICEF and WHO hired a private company who undertook third party monitoring (TPM) to monitor their programs in this outbreak. Although difficult, it is possible to improve the monitoring and reporting in remote districts.

	<b>Recommendation</b>	<b>Lead agency and other parties</b>	<b>Yemen-specific and/or future epidemics</b>
<b>4.1</b>	DTCs and ORCs networks should be mapped according to population and epidemiological needs, particularly in the second and third zones. Smaller DTUs (e.g., less bed capacity) should be considered for locations closer to communities.	<b>WHO, Health cluster,</b> UNICEF, Government(s) of Yemen, INGOs and NNGOs, donors	Yemen-specific and future epidemics
<b>4.2</b>	Ensure all populations have access to an ORC within one hour walk. Utilize the recommended ratio of 5 to 8 ORCs per DTC as a minimum standard.	<b>WHO, Health cluster,</b> UNICEF, Government(s) of Yemen, INGOs and NNGOs, donors	Yemen-specific
<b>4.3</b>	Operationalize community-based care for cholera epidemics as soon as possible by taking advantage of existing CHV networks and Red Cross/ Crescent Society volunteers to staff ORCs, conduct case finding, and refer to care.	<b>WHO, Health cluster,</b> UNICEF, Government(s) of Yemen, INGOs and NNGOs, donors	Future epidemics
<b>4.4</b>	A referral/transportation system should be prioritized and funded as part of contingency planning for a surge in cholera after the second wave.	<b>WHO, Health cluster,</b> UNICEF, Government(s) of Yemen, INGOs and NNGOs, donors	Yemen-specific
<b>4.5</b>	Establish DTCs as temporary structures adjacent to existing health facilities in order to ensure adequate IPC and continuation of routine health services	<b>WHO,</b> Government(s) of Yemen, INGOs and NNGOs	Yemen-specific
<b>4.6</b>	Ensure pre-positioning of tents and supplies to allow for rapid scale up as needed.	<b>WHO, Health cluster,</b> UNICEF, Government(s) of Yemen, INGOs and NNGOs, donors	Yemen-specific
<b>4.7</b>	Create and maintain catalogue of standby/existing treatment facilities including ORCs, DTUs, and DTCs.	<b>WHO, Health cluster,</b> Government(s) of Yemen, donors	Yemen-specific
<b>4.8</b>	Ensure that the October 2017 guidance and mechanisms to activate and decommission DTCs is disseminated and applied.	<b>Health cluster,</b> Government(s) of Yemen	Yemen-specific
<b>4.9</b>	Develop a standardized system to track functionality, capacity, and quality of clinical care at these treatment facilities	<b>Health cluster,</b> Government(s) of Yemen	Yemen-specific
<b>4.10</b>	Maintain an agreed upon number of district-level ORCs as part of the health system.	<b>UNICEF,</b> Government(s) of Yemen	Yemen-specific
<b>4.11</b>	Develop IEC campaigns targeting adults and emphasizing the effectiveness of ORT in treating AWD and suspected cholera.	<b>UNICEF,</b> Government(s) of Yemen	Yemen-specific
<b>4.12</b>	Reinforce effectiveness of ORT in treatment of AWD and suspect cholera in health care worker refresher trainings while stressing the need to use IV and antibiotics only in severe cholera cases.	<b>WHO,</b> UNICEF, Government(s) of Yemen, INGOs and NNGOs	Yemen-specific
<b>4.13</b>	Establish a working group on case management under the CTF which discusses these issues and provides the best practices based on evidence and experiences from other contexts.	<b>UNICEF,</b> Government(s) of Yemen	Yemen-specific
<b>4.14</b>	Expand and fund remote supervision to improve data collection, laboratory practices, and quality of practices in more remote areas by considering various technological solutions (e.g., the same used in telemedicine), working closely with national NGOs, and by employing TPM organizations. The CTF could be made responsible for addressing this gap.	<b>WHO,</b> UNICEF, Government(s) of Yemen, INGOs and NNGOs	Yemen-specific and future epidemics
<b>4.15</b>	Examine the third-party monitoring results from UNICEF to understand the minimum standards of monitoring and supervision that are achievable even if results cannot be delivered to the country office in real time.	<b>UNICEF</b>	Yemen-specific and future epidemics
<b>4.16</b>	Build up the function of the health RRTs to provide basic supervision and ad-hoc monitoring of DTCs and ORCs in their catchment area.	<b>WHO,</b> Government(s) of Yemen	Yemen-specific

## 3.5 WATER, SANITATION, AND HYGIENE (WASH)

WASH interventions can interrupt the transmission of diseases spread through the fecal-oral route, such as cholera and other diarrheal diseases.<sup>92</sup> WASH interventions fall into five categories: 1) increasing water quantity; 2) improving water quality; 3) isolating feces from the environment; 4) promoting (and facilitating with materials) personal hygiene; and 5) reducing environmental risks. The goal of such interventions implemented in the development context is the provision of long-term, population-level, sustainable access to infrastructure. For example, this includes the installation of a borehole with accountability to a water management committee, construction of latrines to isolate feces from the environment, conducting mass handwashing promotion campaigns, and/or creating an enabling environment for WASH services.<sup>93</sup> During an outbreak response, the goal of WASH interventions is to rapidly interrupt transmission routes relevant for a particular disease (e.g., trucking safe water into an area that lacks safe water, chlorinating water along the water chain, and/or disinfecting the households of cholera patients to prevent ongoing transmission to family members and neighbors).<sup>92</sup> Generally, infrastructure development is not implemented as first-line outbreak WASH response.<sup>92</sup>

Yemen is the 25<sup>th</sup> most water-stressed country in the world.<sup>5</sup> Access to water is challenging, as its entire geographical area is categorized as ‘extremely water scarce’. The average annual rainfall is 17 to 20 centimeters, falling mainly as localized high-intensity rainfalls.<sup>94</sup> Due to population growth and the lack of recharge from rainfall, the aquifer beneath Sana’a is being rapidly depleted.<sup>95</sup> Yemen is considered to be the first country that will deplete an urban aquifer completely, leaving no water source available for the city of Sana’a. Within this context of extreme water scarcity, in 2015, before the cholera outbreak, 70% of Yemeni’s had access to an improved water source (63% urban, 85% rural) and 60% had access to improved sanitation (44% urban, 67% rural).<sup>96</sup>

### 3.5.1. WASH ACTIVITIES BEFORE AND AFTER THE CHOLERA OUTBREAK

Before the conflict and cholera outbreaks, UN agencies and international and local non-governmental organizations were undertaking development-style, comprehensive, generalized WASH programming, including water supply provision, sanitation provision, hygiene campaigns, and solid waste management. INGOs reported completing comprehensive WASH programming, such as one NGO who stated that they completed “*rehabilitating water supply schemes*”, “*improvement of sanitation in terms of improving the latrine coverage*” and “*hygiene promoters who have been working with the community for general hygiene promotion to counter WASH situations*”. Another NGO stated “*prior to the outbreak [our] focus has been mainly on what I would call regular WASH. Implementing rural WASH programs. For example, transitioning over improving water supply systems, construction of latrines, community mobilization, and hygiene promotion.*” When the first wave of the outbreak began in late 2016, the INGOs, for the most part, continued this generalized WASH programming, with minor modifications to account for cholera. Numerous INGOs reported that:

- “*Prevention efforts will be the same [for cholera throughout the world]: provision of safe water, provision of sterile basic sanitation, controlling open defecation, promoting hygiene behaviors*”, and the interventions they promoted were “*repair the existing networks*” “*rehabilitate the latrines and latrine needs*”, and “*interventions in the health facility around medical waste management*”. Additionally, this NGO reported distributing hygiene kits and ceramic filters, as well as Aquatabs brand chlorine tablets and soap;
- While they modified their WASH programming to focus on cholera hotspots, the programming remained focused on providing water trucking and rehabilitating community water schemes; training volunteers on hygiene promotion, chlorine tablet distribution, hygiene kit distribution, referring people to cholera treatment centers and, providing handwashing stations and incinerators at cholera treatment centers;
- They transitioned to a cholera-specific program focused “*on water treatment at community level, water treatment in schools, water supply*





*which involve trucking, rehabilitation of pipelines and other water sources like boreholes, but also sanitation related issues, temporary latrines, and the rehabilitation of latrines. There was also the software component; issues to do with cholera prevention messaging, and we came up with about, I think that there are six key messages, that we focus on”;*

- It was a struggle for local teams to move beyond the general interventions of trucked water and latrine coverage and solid waste disposal to interventions specific for cholera response, such as fuel subsidies and operations and maintenance grants. Additionally, this respondent noted that this large INGO put in a large water system for a community of people that had to move due to conflict, and thus the water system was abandoned soon after installation;
- They completed “*three consecutive months of [distribution] of a cholera intervention kit*”, including a 20-Liter jerrycan with sufficient Aquatabs to last an average family of six for the whole month for their drinking water plus hand washing soap using blanket targeting for approximately 30,000 families.

As can be seen from the above statements, the INGOs interviewed generally continued generalized WASH programming, including, water supply, water treatment, sanitation, hygiene, and solid waste management, during an outbreak response. While there were some modifications, such as targeting these WASH interventions to cholera hotspots, adding cholera messages into existing hygiene programming, or working in DTCs to manage waste, the programs themselves remained broad WASH programs. Additionally, these programs were community-based, and small-scale relative to the size of the outbreak, reaching on the order of tens of thousands of people per program. These programs were not WASH activities specifically targeted to those at risk of transmission to break the transmission routes of cholera in a large-scale conflict-affected outbreak. The results above are not inclusive of all INGOs working in Yemen, but of many of whom were interviewed.

In interviews, the donors funding these programs noted this focus on generalized WASH programming as well, stating:

- “*The overall struggle we’ve had with the cholera response is that, when the initial reprogramming came in in 2016, it didn’t look like a cholera response. It looked like a WASH IDP [internally displaced persons] response*”;
- “*There’s still a lot of stuff in there that’s not necessarily cholera specific*”;
- “*The activities proposed by the WASH cluster weren’t really appropriate for cholera outbreak. There was a lot on sanitation, both construction and rehabilitation of latrines, work on sewer networks, and solid waste management*”;
- “*It took a year and a half and well into the second phase of the outbreak before the kind of specific cholera interventions that are related to WASH actually kind of started and got rolled out*”;
- “*None of our partners talked about looking at the transmission context and trying to understand, okay, where is transmission potentially coming from?*”.

This lack of cholera-specific WASH programming is reflected in WASH activities reported by the WASH cluster. In 2017, 47 partners reported cholera WASH activities. In a late 2017/early 2018 evaluation by the WASH cluster, the majority of beneficiaries were reached through water and sanitation system support to target urban districts (including fuel, operations and maintenance support, rehabilitation, and sewage treatment plant support (Table 2)).<sup>97</sup>

**Table 2: Beneficiaries reached in WASH in 2017<sup>49</sup>**

Rehabilitate water infrastructure:	2.4 million
Sewage treatment plant support:	3.4 million
Solid waste collection in urban:	2.1 million
Water infrastructure in institution:	0.46 million
Water trucking:	1.5 million
Water filter distribution:	0.15 million
Chlorine tablet distribution:	1.1 million
Latrine construction:	0.018 million
Hygiene kit distribution:	1.6 million
Community mobilization:	1.3 million

UNICEF, as the ‘provider of last resort’ and the WASH cluster lead, took a much larger role in implementing interventions (in addition to coordinating) in this outbreak.<sup>49</sup> UNICEF had the best capacity to import materials through their logistics hub in Djibouti, and UNICEF could sub-contract with local organizations and the government. Respondents estimated that UNICEF implemented, with partners approximately 50 to 60% of the WASH response. This is reflected in the large numbers of people reached directly by UNICEF-supported programs of rehabilitation of water infrastructure, sewage treatment plant support, solid waste collection, and water infrastructure. INGOs were focused more on water trucking, latrine construction, chlorine tablet distribution, filter distribution, hygiene kit distribution, and community mobilization.

The generalized WASH programming was not limited only to INGOs, as a national Yemeni NGO interviewed also mentioned their programming included latrines, water trucking, cleaning campaigns and solid waste management. Specific programs mentioned were working with 300 volunteers to deliver hygiene kits and hygiene messages in Sana’a, and installing solar systems in health centers. It was specifically stated that to “*adopt a comprehensive approach, this is usually the most successful approach or intervention we would do.*” Additionally, “*This is usually the combination that we work on, so we usually start with the awareness, then a little bit later we started the construction of the water tanks, of the latrines, landfills construction and water trucking and so on.*”

Donors and INGOs also reported struggling with what WASH interventions were, and were not, appropriate to be implemented. For example:

- At the outset of the outbreak, direct chlorination of wells was being promoted and completed, yet this intervention is known to be ineffective. The WASH cluster wrote a guidance note to recommend ceasing this activity;
- Throughout the outbreak, common cholera-response activities in other crisis-affected areas such as bucket chlorination (where an attendant sits at the water source and chlorinates the water as it is being collected into a container) or household spraying (going to a cholera patients’ households and spraying with chlorine to prevent inter-familial transmission) were not

being completed by responding organizations. The respondents did not shed light on why these activities were not being used by implementers;

- There was significant discussion as to whether chlorine tablets or locally-available ceramic filters were the most appropriate to distribute. Chlorine tablets had the benefit of reliable supply available internationally and locally, but the drawback was the taste and odor concerns. Ceramic filters were thought to be more appropriate, however, there are concerns with the quality of local suppliers and whether ceramic filters reduce the concentration of *V. cholerae*. Despite the lack of knowledge or recommendation from the WASH cluster as to how to proceed, significant numbers of both tablets and ceramic filters were distributed; and
- Widely available international resources for how to complete WASH programming to respond to cholera, such as the UNICEF Toolkit, were not being used by implementers.<sup>18</sup>

### 3.5.2. EVOLUTION OF CLUSTER-LEVEL WASH RESPONSE PLANS AND RRTS

Concurrent with the international NGO programming, the WASH cluster was working to develop WASH strategies. In the first wave of the outbreak, the first strategy focused on developing standard operating procedures, halting ineffective programming being promoted (in particular, well chlorination), and developing a strategic approach. In October 2016, an integrated cholera preparedness and response plan was released, however the WASH components remained general, recommending blanket distribution to generalized high-risk areas (where confirmed or suspect cases were documented) rather than targeted interventions to cholera-affected households and communities.

The May 2017 cholera preparedness and response plan was updated in preparation for an anticipated 98,126 cases in the second wave. This plan targeted the response to 227 high-risk districts, and recommended the use of risk management strategies such as water safety planning, water quality monitoring, chlorination of water at all points of the water chain, water storage container cleaning, distribution of hygiene kits and chlorine tablets, and communication and mass



awareness raising. Sanitation was only recommended on a “case-by-case” basis, if sanitation was found to be a transmission route.

In this plan, indicators were established to measure the effectiveness of this work, including:

- Percent of beneficiaries receiving soap and chlorine tablets and who properly utilize the materials (target: 75%);
- Percent of tested chlorinated water with FRC > 0.2 mg/L and turbidity <10 NTU (target: 90%); and
- Percent of affected villages sensitized on cholera prevention and water treatment (target: 75%).

While this plan was based on UNICEF’s “Shield and Sword” approach to prevent cholera, and it targeted specific districts based on epidemiological risk, it still recommended a blanket distribution strategy within those districts.<sup>71</sup> As the second wave was much larger than anticipated, it became unfeasible to carry out this blanket distribution strategy in a timely way.

In July 2017, after months of trying to secure their entry into Yemen, and during the peak of the second wave, UNICEF and WHO were able to send WASH staff with expertise in cholera into Yemen to provide the technical assistance required to develop a cholera-specific response strategy. This strategy built upon recent expertise in WASH for cholera response, similar to the WASH RRT approach used for early response to the Haiti outbreak.<sup>98</sup> It should be noted that WASH RRTs were established in Haiti not during the height of the outbreak in 2010/2011, but after endemicity set in. In Yemen, the RRT approach reached scale only when transmission was geographically widespread and during the peak of the second wave.

Over July and August 2017, a strategy was developed and operationalized (published in April 2018), working with UNICEF Yemen, the WASH cluster, and GARWSP, including chlorination at all points in the water chain to reduce transmission risk in hotspots, using decentralized RRTs and targeted response to households of cholera cases to prevent intra-familial and neighborhood transmission. The strategy included:

- *Targeted response to households of cases.* WASH RRTs were established and operationalized in September 2017, and managed at the level of the 22 governorates. At the peak in 2017, more than 1,600 RRTs were in place across the country (the number of RRTs varies with caseload across the governorates). RRTs use the line-list data received from health counterparts to go to the homes of cholera cases within 24 hours of DTC admission. The RRTs provide cholera prevention kits (chlorine tablets for water treatment, soap and laundry powder for washing, chlorinated solutions for disinfection), and hygiene education including dissemination of materials with key cholera prevention messages. The RRTs share weekly reports to learn from one another. Additionally, a TPM mechanism was established to monitor the RRTs and report results back. The study team attempted to obtain these reports, but permission for data release was not granted. It is of note that, while the RRT strategy is considered successful in Haiti, there has been, to date, no formal evaluation of the implementation, outcomes or impacts of the RRT strategy in Haiti or in other contexts. However, there is an emerging body of evidence for case-based intervention which can address the high risks of intra-and inter- household transmission.<sup>99,100</sup>
- *Hotspot response to ensure water is chlorinated throughout the water chain.* The second portion of the strategy was to “*get ahead of the outbreak*”, by targeting hotspots (areas with more than five reported cases of cholera) and ensuring there was FRC at all points in the water chain with the main goal of increasing FRC in household drinking water. This included assessment and mapping of WASH infrastructure with quick cost effective fixes to water and sanitation infrastructure, provision of chlorinated water through water trucking (where appropriate), disinfection of water points and storage facilities (jerrycan and tanks), chlorination of water supplies (piped network, private water trucks, tanks,

but no wells), distribution of cholera prevention kits (household chlorine tablets, jerry cans, soap and IEC materials) at household level, including post distribution monitoring, water quality monitoring (FRC) at source and point of use (household level), and hygiene promotion, community mobilization and cholera awareness messaging. It is of note that there is evidence from Syria that this strategy increases FRC in household drinking water, and thus could reduce the risk of cholera transmission,<sup>32</sup> and

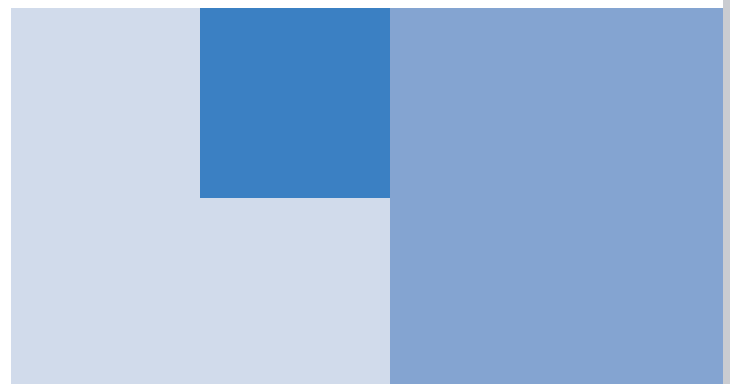
- *Coordination* with a commitment from the WASH and health clusters to have national level joint meetings to coordinate, stating that “WASH partners will continue to link directly with health counterparts to ensure immediate access [emphasis added] to epi data, ensuring cholera response is timely and targeting newly reported suspected cholera cases and the immediate surrounding households”. Additionally, the strategy stated that health partners would be responsible for IPC in DTCs and ORCs, with WASH partners providing technical support as per the health partner request. This is a change from the previous plan, when only WASH was responsible for IPC in DTCs and ORCs.

Thus, in September 2017, 12 months after the start of the first wave of the outbreak, and after the peak of the second wave, a cholera-specific WASH response was operationalized. This response aimed to be specific, proactively get ahead of the outbreak, target specific hotspot areas, and interrupt transmission. A major benefit of this strategy, because it was run through the governments, is that there was both access and scale. The RRTs, as compared to NNGOs and INGOs, could access households. The major limitation of this strategy was the time it took to implement and context-specific factors that prevented this strategy from being as effective as planned.

A gap that remained at this time, however, was Communication for Development (C4D). In reviewing UNICEF’s work on C4D, evaluators noted that “tasks and responsibilities in terms of C4D are not clear” and “there should be more attention for C4D.”<sup>49</sup> The main C4D house-to-house campaign was not completed until August 2017, well after the peak of the outbreak, and was not operationalized as completely as the RRTs even after that.

An additional gap that remained was monitoring. While 64% (16/25) of responding partners reported routinely completing post-distribution monitoring and FRC testing survey of WASH cluster partners, there were significant difficulties in collating FRC data at the cluster level, and in obtaining data for this report. FRC was obtained from two INGOs for this report. One set of data was from approximately 2,000 households, and every data point was between 0.2-0.7 mg/L FRC. Another set of data was from approximately 50 trucks, and every sample was 0.4 mg/L FRC. While these are ideal FRC concentrations, it is unlikely that each house and truck had ideal FRC given the Yemen context. Additionally, two qualitative reports of evaluations in were provided by INGOs to the evaluation team. Both found the majority of households obtained water from vendors and that households generally had good knowledge of cholera information from TV, radio, and health workers. One mentioned that home remedies were used to treat cholera, and that there was some fear in health-seeking behavior due to gender concerns (e.g., females accessing treatment, and in particular how to remain covered according to their religious beliefs during treatment). Additionally, beneficiaries reported it could be difficult to adopt hygiene practices because of the limited water availability, and there were varying acceptability levels for the chlorine tablets.

The question then is “Why did it take so long to operationalize the WASH response?”. The answer is related to four barriers and facilitators suggested by respondents, discussed below.



### 3.5.3. BARRIERS AND FACILITATORS TO CHOLERA-SPECIFIC WASH PROGRAMMING

Respondents extensively discussed barriers and facilitators to WASH programming in the Yemen outbreak response, and they are broken up in to the following categories:

- Obtaining Cholera-WASH technical assistance, Security;
- Coordination;
- Line-list Access;
- Funding.

#### 3.5.3.1. Obtaining cholera-WASH technical assistance, security

Every responding organization discussed the negative impact of security on WASH programming. This was discussed as a major limitation to programming, and is attributed to the fact that WASH programming, by definition is spread out in the community and households.

The first impact of the conflict on WASH was the difficulty in conducting work in the context, including difficulties in:

- Obtaining visas, particularly for WASH-cholera experienced personnel;
- Obtaining approvals to travel within country;
- Transiting materials and supplies (particularly into the country and across the North and South border); and
- Maintaining safety and security of all staff.

Both INGOs and NNGOs noted these security concerns. It was not only INGOs who struggled; although some respondents stated that NNGOs generally had better access than INGOs. In many cases, staff could not leave their office, and that led to staff – literally – not knowing what was actually happening in the programs. These issues made the response less technical, slower, and more expensive. Technically, it was difficult to

justify spending on a technical WASH staff with such a low staff ceiling. Partners found that to increase the speed of the response they could use prepositioned supplies, work with UNICEF suppliers, and have pre-arranged agreements with in-country suppliers. Some

*So, there are quite a number of challenges: security, access issues, bureaucracy from whoever you're dealing with, and the logistical challenges because of the blockade and permissions.*

*For every field visit, you need to get permission.*

*I haven't been allowed by the authorities to be able to access the field where our teams are working ... I've only had very limited success in seeing beyond the office.*

*The security is a major impediment, but somehow, they've seemed to continue mobilizing.*

*We've done this before guys why are we making it complicated for Yemen just because Yemen is a difficult country, it's got war, it's got conflict, it's got famine, no different than a lot of countries we work.*

*The staff ceiling that was extremely strict.*

*I, myself, did not go to Yemen, unfortunately, due to visa issues.*

All anonymous



partners, who previously did not manage their own air transit flights, began air transit to obtain materials, as UNICEF supplies could only provide so much of the massive response that was required. All of this increased the cost of the response substantially.

### 3.5.3.2. Coordination

The coordination of WASH activities occurred at the national cluster and sub-national cluster level. Additionally, activities were coordinated with the health cluster, the Cholera Task Force, and the IMS/EOCs established by WHO Yemen and the MoPHP.

Key informants were almost universally positive about the national-level cluster coordination that occurred from Sana'a. In particular, there was high praise for the cluster lead, who uniquely, was the cluster lead for three consecutive years. Informants stated that meetings were well-organized, there was good technical assistance and information provided, that the cluster worked on importation of WASH materials, and that the cluster led a review and lessons learned workshop. It was noted, however, that the Cluster Coordinator did not have cholera experience prior to working in Yemen.

There were less positive perspectives regarding the sub-national clusters, and working with the cluster system in Aden. In particular, coordination and technical assistance issues were noted, with meetings scheduled too late for partners to obtain the required security clearances to attend and technical knowledge about specific cholera response WASH expressed. It is unclear if remote access to meetings (e.g., WhatsApp, Skype) could have been used. Additionally, the WASH cluster meetings were not considered accessible to NNGOs, as one NNGO stated: *"I myself was there [at a cluster meeting] for one or two times, but I felt that I was totally out of coverage because they were discussing things or they were voting for things they have already decided not in my presence."*

The relationship between the WASH cluster and health cluster was considered good by informants, and attributed to a strong personal relationship between the cluster leads. There was concern expressed about both cluster leads leaving before the anticipated third wave of the outbreak. Despite the relationship between the WASH and health clusters, there were concerns

expressed about how some issues that straddle WASH and health were managed, including IPC, OCV, and the IMS.

The question of who would be manage IPC in DTCs and health facilities was fraught. In the 2018 strategic plan it was determined that IPC would be managed only by health actors, and WASH could be involved only if health actors requested assistance. WASH actors expressed concern that health actors might not have the knowledge of WASH functions, such as ensuring chlorine solution concentrations were correct for disinfection. The question of where IPC should be managed, and monitored from, is not unique to the Yemen outbreak, and is one of the topics of investigation in a current Geneva-level project looking into coordination between the WASH and health clusters.

*We don't have direct engagement in OCV.*

*The OCV campaign was not really discussed with us.*

*Bringing everybody to the table to actually make critical decisions on strategy, especially around the key things where there are a WASH and health overlap, I think that those discussions just never move forward quick enough.*

*Misunderstanding of WHO on role of WASH.*

*Complete lack of understanding of expectation of each sector.*

*So I'm not faulting WHO or UNICEF on how that happened; I think it's a collective failure.*

All anonymous



While respondents universally expressed strong support for OCV, they also stated WASH actors in general and the WASH Cluster specifically, reported they were not included in OCV discussions. This occurred even though parts of the OCV application concern about describing WASH access and WASH programming. WASH actors stated that they could assist in helping target OCV, and provide WASH activities in conjunction with OCV distributions, as necessitated.

The most negative comments heard from respondents were about the IMS/EOC system established in the second wave (commonly referred to as the “EOC”).

*So, the EOCs were established right around the time when we were finally getting our response plan in place and a strategy that was starting to be kind of commonly understood.*

*I think when you have a national disaster response framework and a country that's very well prepared, you know a command and control model works very well, but it is very dangerous because it's counteractive to a collaborative approach which is basically how the clusters work.*

*[The EOC] ended up being quite a bit of additional work without any real benefits.*

*I think in the end it [EOC] was completely a failure.*

*WASH partners [were told] they would stop their working permits if they attended the EOC meetings.*

All anonymous

Respondents felt the IMS/EOC was established without input from WASH actors, and without consideration of how to integrate the cluster system and the IMS/EOC. In the end, informants felt the IMS/EOC added little-to-no value, and as the goals were not clear. Its introduction created much confusion. Many respondents were confused whether the IMS/EOC system remained in existence or not at the time of the interview. In particular, given that the national EOC took over information management functions and situation reports, WASH respondents expressed that the creation of the IMS/EOC prevented WASH from obtaining the basic data it needed to target cholera-affected households.

### 3.5.3.3. Line-list access

Once cholera specific WASH programming to prevent transmission was established in the RRTs, there was a need for timely access to the epidemiological data. There was significant tension described by respondents about the lack of timely access to the line-list data.

In the Haiti outbreak, where the RRT program was scaled-up before Yemen, it was not a conflict area with two governments, and it had a strong Ministry of Health presence with significant external support that maintained an active cholera surveillance network. Thus, the line-list in Haiti was managed centrally, collated rapidly, and available within one day such that RRTs could go to the cholera-affected households within 48 hours of case admission. The context was different in Yemen. The line-list was outdated by one to two weeks when released, and not formally available to WASH partners in any case. In the second wave, a system was arranged for WASH partners to have informal access to the line-list via a back door. However, this was still not timely enough for the RRTs to obtain the case information within 48 hours, which is believed necessary to interrupt intra-familial and neighborhood transmission routes.<sup>101</sup>

*We didn't have the basic epidemiological data to help us make decisions.*

*I realize now that access to the line list is not necessarily like a silver bullet. I mean the ones who I think realized that the connection with the health center was more valuable were able to respond better.*

*The WASH sector felt very disappointed that they were unable to get up-to-date epidemiological information to help them target their response into areas in a real-time way.*

*We can suspect it's cholera, if it's AWD it's still killing people and we still need to deal with it.*

*Even if it's 250,000 cases of suspected cholera, it's still massive.*

All anonymous

Some respondents overcame this by instead obtaining case information directly from DTCs. For example, the RRTs organized by the government reported going to the DTCs daily to obtain the line-list.

Additionally, the reported poor application of the case definition led to RRTs arriving at a home that did not appear to have anyone infected with cholera. To accommodate for this and the high caseload, RRTs were only deployed for clusters of five to 20 suspected cholera cases. While the consensus within the WASH sector was that it did not matter if it was cholera or another diarrhea, as it still needed to be treated and prevented, there was a balance that needed to be struck between actual cases and limited WASH resources needed to be developed.

#### 3.5.3.4. Funding

The international agencies and NGOs reported that overall there was sufficient funding for the response, particularly once the response was targeted. Some international agencies and NGOs reported more funding would have been useful to increase the blanket distribution projects in targeted areas, such as hygiene kits and fuel to operate the water and sanitation infrastructure. However, there was a question of the utility of the hygiene kit mass distributions, in particular for cholera control.

Conversely, NNGOs and the government noted insufficient funding. NNGOs reported that they did not have enough funds to maintain their operations, and there were large delays in receiving funds that NNGOs, with small cash reserves, could not absorb. The government noted that while funding was available to maintain or repair existing infrastructure, the funding needed to reconstruct water systems was not available. In particular, communities visited by the RRTs requested not only immediate assistance with cholera-response WASH, but also longer-term assistance with water and sanitation infrastructure; for this aspect, there were severely limited funds.

*Money was not a problem in this response and I think we should make that clear.*

*I think there was a lot of money for cholera; I don't think there is enough for preparedness.*

*Never was the funding a bottleneck.*

All anonymous



### 3.5.4. THE ROLE OF ORGANIZATIONS IN WASH PROGRAMMING IN L3 EMERGENCIES

Overall, the information gained from key informant interviews related to WASH in this section leads to a question of the role of organizations in WASH programming in L3 emergencies. WASH programming is by its very nature household- and community-based. This means to complete WASH programming, one must have access to all levels of the community, not only infrastructure.

*I just feel like it has always been this hard-to-staff place where, because you can still be in the country, I think there's this expectation that you continue to work in the way that NGO's work when access is not a problem.*

Anonymous

There are strong data and recommendations on how to prevent and control cholera with WASH activities in high-income contexts (e.g., water and sanitation infrastructures) and low-income stable contexts (e.g., specific WASH activities to break the chain of transmission, including chlorination at source (bucket chlorination) and household, behavior change messaging, and household disinfection. However, there are less data and recommendations for insecure and inaccessible settings like Yemen.

A particular point raised by respondents was the role of INGOs in cholera response. While a few INGOs completed community-based programming in response to the outbreak, in the end those programs reached a relatively small number of beneficiaries with a relatively high cost. There is a question, due to the access restrictions, whether it would be more effective for INGOs to take on an advisory and financial role, and directly train and support local organizations, community health workers, and YRCS volunteers, to undertake on-the-ground programming.

*One thing that I keep raising is that I think the cholera response in Yemen is a unique one.*

Anonymous

This was expressed by the few NNGOs in comments, including:

- “They [INGOs] are not aware or don’t want to be aware of that the Yemeni civil society or the Yemeni community does exist.
- “We have so many INGOs and regional NGOs coming to Yemen and they are taking over the implementation ... we continue telling people you have been working in Yemen for the last 40 years.”
- “Now they have like hundreds and thousands of consultants.”
- “They are not better than us.”
- “They are much less experienced than the Yemeni staff.”
- “I really need the international organizations to play a vital role towards the NNGOs... I would really recommend to do a capacity building for local NGOs who are located in the field because for two reasons.”
- “When they leave, they leave with all the knowledge they have.”

INGOs and international agencies in the WASH sector, working at the household and community levels, were attempting to undertake a response that was quite difficult to do in the insecure and access-constrained context of Yemen. It was only with the government involvement in the RRTs, and the involvement of the private sector with water trucking and other interventions, that cholera-response specific WASH activities were able to begin to be scaled-up to the level needed for the massive cholera outbreak in Yemen. In the next phase of response, the questions will involve how to link the RRT programming with other programming to fully encompass the WASH response.

	<b>Recommendation</b>	<b>Lead agency and other parties</b>	<b>Yemen-specific and/or future epidemics</b>
<b>5.1</b>	For early control, immediately focus on a strategy providing decentralized, targeted WASH responses to interrupt transmission related to known confirmed and suspected cholera cases (case- and household-based intervention), such as WASH RRTs, chlorination in hotspots, and hygiene promotion.	<b>UNICEF, WASH cluster including INGOs and NNGOs, Government</b>	Future epidemics
<b>5.2</b>	Given that experience in cholera control may not be part of the WASH toolbox in-country, ensure that rapid trainings of national and INGOs by appropriate organizations occur in areas that are secure); in addition, consider deploying a cholera expert to the WASH cluster, or having such expertise on the Cholera Task Force.	<b>UNICEF, WASH cluster including INGOs and NNGOs</b>	Future epidemics
<b>5.3</b>	A small set of RRTs should be pre-emptively trained and placed on standby to respond to cholera (and other outbreaks), enabling the early targeting of a localized response and containment when there are few case clusters; RRTs should be well-resourced as the outbreak declines in magnitude to allow for containment of small, remaining case clusters.	<b>UNICEF, WASH cluster</b>	Future epidemics
<b>5.4</b>	Consider the appropriate role of all partners in a response, including agency, government, INGO, NNGO, and private sector. In particular, consider alternative approaches to the provision of remote support, e.g., video based trainings, ensuring a help-desk feature for their field staff with rapid turnaround on technical questions, more proactive remote support, developing implementing partner relationships with local NGOs and associations where feasible.	<b>UNICEF, WASH cluster including INGOs and NNGOs, Government</b>	Yemen-specific and future epidemics
<b>5.5</b>	Work more extensively with the private sector, government(s) and NNGOs who may have better access to deliver programs and services, such as water supply (e.g., trucking) and water treatment (e.g., chlorine tablets).	<b>UNICEF, WASH cluster including INGOs and NNGOs, Government</b>	Yemen-specific and future epidemics
<b>5.6</b>	Continue collecting, and centrally analyzing and gleaning lessons learned from TPM data using FRC in water (trucks, households, networks), as the primary outcome indicator, and also evaluate household disinfection kit distributions.	<b>UNICEF, WASH cluster including INGOs and NNGOs</b>	Yemen-specific
<b>5.7</b>	Donors and WASH cluster with Ministry of Water should strategize and complete as much rapid work on water supply and sanitation infrastructure as feasible, while advocating and partnering with large bilateral and multilateral donors on repairing and maintaining infrastructure for medium to long-term prevention of water-borne diseases. This can be facilitated by ensuring there are WASH specialists trained on infrastructure repairs, operations, and maintenance able to work in Yemen.	<b>UNICEF, WASH cluster, Government(s) of Yemen</b>	Yemen-specific
<b>5.8</b>	Key WASH practices (e.g., hygiene promotion, safe water) should be maintained during provision of OCV to have synergistic gains.	<b>UNICEF, WASH cluster including INGOs and NNGOs, WHO, health cluster, Government</b>	Yemen-specific and future epidemics
<b>5.8</b>	Strengthen C4D by prioritizing and funding this work, and utilize existing resources such as YRCS volunteers and CHWs for implementation.	<b>UNICEF, WASH cluster including INGOs and NNGOs, Government(s) of Yemen</b>	Yemen-specific





### 3.6. INTEGRATED HEALTH AND WASH STRATEGIES AND INTERVENTIONS

In addition to the sector-specific recommendations above, additional recommendations highlighting areas of integration between health and WASH, as well as standards and research that are discussed below.

This epidemic has revealed opportunities for the health and WASH sectors, among others, to work closely together, whether through the cluster systems or directly between WHO and UNICEF. This was demonstrated through the implementation of OCV and social mobilization efforts, and coordination under the World Bank funding. Several complementary strategies were identified between the health and WASH sectors that demonstrate the opportunities for further integrated programming. Some of these strategies and interventions were mentioned in the individual case management and health and WASH sections above. While integration of the cholera response should include all relevant sectors, we have chosen here to concentrate upon health and WASH. Below is a list of the recommendations.



Recommendation	Lead agency and other parties	Yemen-specific and/or future epidemics
<p><b>6.1</b> Planning should be integrated between the health and WASH sectors on the following strategies and interventions:</p> <ul style="list-style-type: none"> <li>▪ Health and WASH RRT lines of communication at local level to use the best data possible to target the response and integrate responses. For example, WASH RRTs should obtain epidemiological case information locally, directly from DTCs, governorates, or districts; WASH and health RRTs can communicate systematically to integrate responses;</li> <li>▪ OCV planning; MoPHP, WHO and the health cluster in Yemen should ensure the strategy for distributing OCV is done in conjunction with the WASH cluster as well as other interventions;</li> <li>▪ IPC in the health facilities; and</li> <li>▪ Water quality and its surveillance.</li> </ul>	<p><b>WHO, UNICEF, health and WASH cluster, Government(s) of Yemen</b></p>	<p>Yemen-specific</p>
<p><b>6.2</b> Given the insecure and remote context in much of Yemen, decentralization of care with community-based approaches to treatment, referral and WASH should be the focus in rural and remote areas:</p> <ul style="list-style-type: none"> <li>▪ Placing ORCs within a one hour walk of communities as a minimum standard, including plan for transportation of patients requiring care at DTCs;</li> <li>▪ Organizing cross-agency networks, and training, and developing their capacities for community-based surveillance, referral to care, staffing of ORCs, and social mobilization and health and hygiene promotion;</li> <li>▪ Placing emphasis on the systematic collection of FRC in household water as the primary indicator of water quality;</li> <li>▪ Strengthen roles of INGOs as technical advisors to NNGOs who may have more access to communities.</li> </ul>	<p><b>INGOs, NNGOs, UNICEF, health and WASH cluster, Government</b></p>	<p>Yemen-specific and future epidemics</p>
<p><b>6.3</b> The response needs to assure that the model for remote technical assistance is effective, accessible, and timely.</p> <ul style="list-style-type: none"> <li>▪ Major technical bodies should provide cholera-specific, multi-day training modules for mixed groups of frontline public health staff from national NGOs and INGOs in Amman or Djibouti, in order to improve the understanding of cholera-specific response;</li> <li>▪ A minimum set of standardized practices and measures should be developed for agency-level remote monitoring and supervision of the cholera response.</li> </ul>	<p><b>UN agencies, other technical agencies (e.g., MSF, CDC, others)</b></p>	<p>Yemen-specific and future epidemics</p>
<p><b>6.4</b> After-action reviews of practice after a cholera outbreak should be standard practice for each responding organization; an after-action review for each agency (e.g., UN, INGOs, NNGOs) after the first wave would have been beneficial for identifying gaps and weaknesses in preparedness that require resolution before the second wave occurred.</p>	<p><b>UN agencies, INGOs, NNGOs, clusters</b></p>	<p>Yemen-specific and future epidemics</p>
<p><b>6.5</b> NGOs should engage with partners so that WASH and health staff have cholera-specific training which covers cholera surveillance, appropriate response, and technical protocols.</p>	<p><b>INGOs, NNGOs, clusters</b></p>	<p>Yemen-specific and future epidemics</p>
<p><b>6.6</b> NGOs should develop remote monitoring processes (e.g., field procedures, tools and checklists, accountability mechanisms) for assuring the quality and scale of intervention in remote, insecure sites; for cholera, this could mean rigorous procedures for use of FRC as a monitoring indicator and providing TPM on a systematic basis for monitoring care in DTCs and ORCs.</p>	<p><b>INGOs, NNGOs, clusters, donors</b></p>	<p>Yemen-specific and future epidemics</p>



### 3.7. ORAL CHOLERA VACCINATION (OCV)

Relative to other interventions, OCV is a new addition for cholera prevention and control. *Shanchol and Euvichol*, both two-dose, low-cost OCVs, are currently maintained in a global stockpile.<sup>37</sup> The stockpile was established for reactive use against outbreaks, and to prevent outbreaks during humanitarian emergencies. Similar to the yellow fever global vaccine stockpile, countries must send a request to the International Coordinating Group (ICG) backed by an epidemiological assessment that shows the risk of spread, and robust plans for vaccination and control using core measures.

The introduction of OCV in Yemen faced significant challenges that delayed its use for both reactive and preventative purposes. The reasons were many and complex, including those common to countries with no previous experience implementing OCV, and those resulting from Yemen's complex political and security environment: MoPHP concerns about the ability to cover an adequate proportion of the population; difficulty targeting the vaccine based on the lack of valid data; a poor operational context for implementation; disagreement within the alliance of loyalists and Houthi divisions of the MoPHP; need to ensure the risk assessment approach does not create misunderstandings of inequity in aid between the north and south; and, skepticism about vaccination.

**Given the current availability of killed whole cell OCVs and data on their safety, efficacy, field effectiveness, feasibility, impact and acceptability in cholera-affected populations, these vaccines should be used in areas with endemic cholera, in humanitarian crises with high risk of cholera, and during cholera outbreaks. The vaccines should always be used in conjunction with other cholera prevention and control strategies.**

*Cholera vaccines: WHO position paper August 2017<sup>39</sup>*

#### 3.7.1 TIMELINE OF CONSIDERATION OF OCV

The timeline for the consideration of OCV clarifies the timing of the decision-making around the potential use of OCV to avert new cases across the first and second waves, and in anticipation of surges in cholera (Fig 6). It does not however imply actions had immediate impacts on the caseload.

*In early days in 2016, WHO proposed OCV, but the MoPHP took a long time to decide. At that time, the outbreak was small scale and the MoPHP needed more time to study the information we provided to them. By January 2017, the MoPHP realized the outbreak was declining and didn't want to agree on OCV.*

*We have to take [this route] for every single vaccine we introduce in this new environment. This is the process. Sometimes it takes longer than expected.*

Senior Advisor, WHO

#### 3.7.2 THE RESPONSE IN THE FIRST WAVE DID NOT FAVOR THE INTEGRATION OF OCV

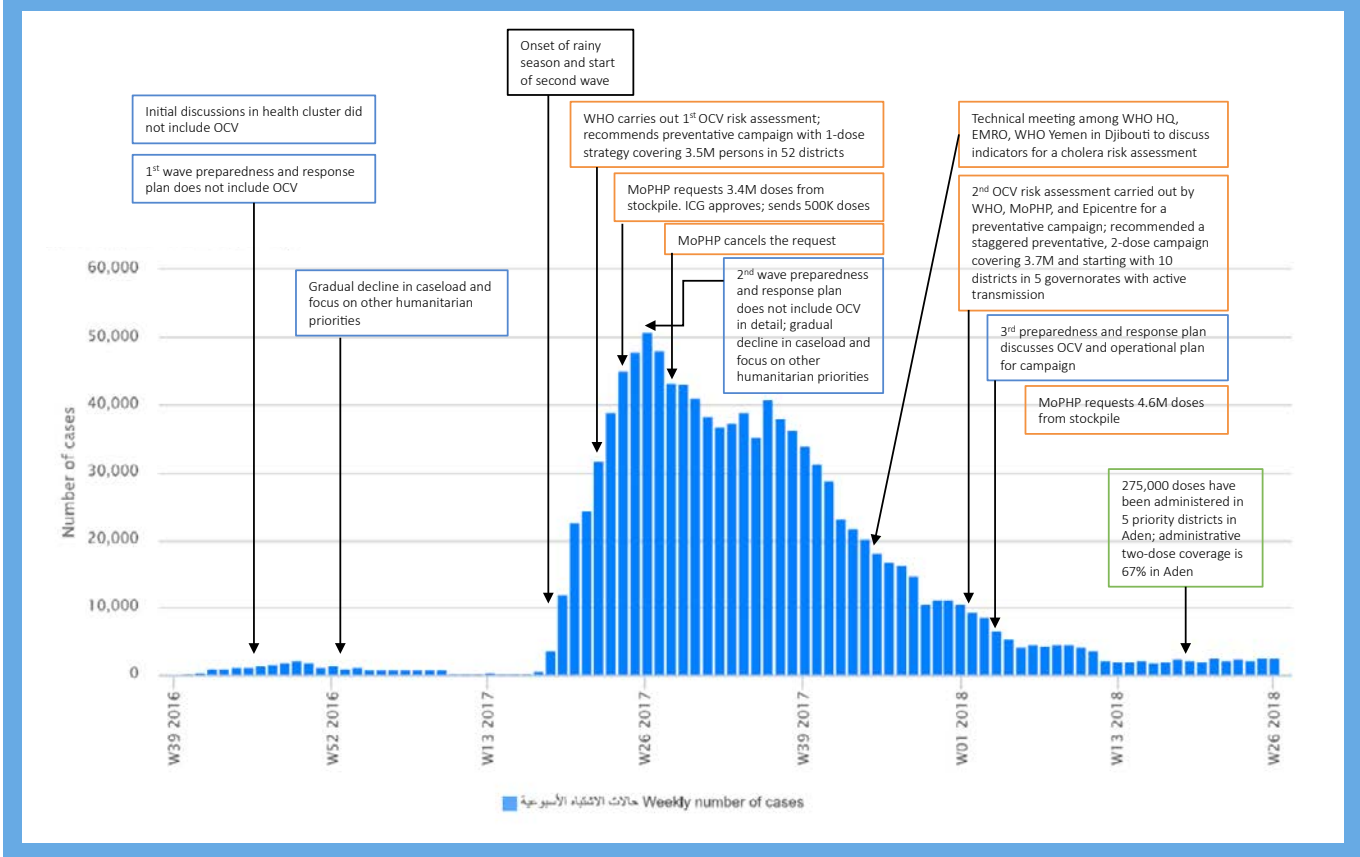
The adoption of OCV during any cholera outbreak requires that a Ministry of Health and its implementing partners have a baseline knowledge of OCV's effectiveness, feasibility in humanitarian emergencies, the process for procurement through the stockpile; and a strong implementation plan.<sup>35,39,102</sup> In Yemen, OCV was not included in a cholera preparedness plan in place before the outbreak, and there was a lack of familiarity and knowledge among the key players from the onset of the first wave. This lack of knowledge is not unique to Yemen, and has affected virtually all countries that consider OCV for the first time. Haiti, South Sudan, Somalia, Iraq, as well as the more stable Sierra Leone, all took several rounds of information sharing and negotiation to prepare a stockpile application.<sup>35,102-104</sup>

At the onset of the outbreak in October 2016, WHO's Cholera Team, EMRO, and others gave consistent advice to the MoPHP and the health cluster to consider a reactive OCV campaign. Several respondents voiced that the key decision-makers in-country at this time were not up to date with the evidence on its effectiveness, feasibility, and the adapted 1-dose strategies used in recent deployments in humanitarian emergencies. The MoPHP eventually saw a declining trend in suspected cholera cases, and consequently shifted its priorities from further discussion of OCV. Multiple respondents, corroborated by the health cluster meeting minutes from this time, spoke of the lack of thorough discussion within the health cluster about carrying out an epidemiological risk assessment for OCV, especially given the potential added value of using it in a humanitarian emergency in areas where lasting water and sanitation improvements would be slow. The health cluster meeting minutes focus primarily on prevention through IPC and WASH and case management and OCV did not appear in the initial October and November 2017 cholera preparedness and response plans<sup>105</sup> (see sidebar).

*The most important measures to curb the cholera outbreak are preventive measures, mainly WASH interventions like provision of clean water and chlorination of water sources. These are to be done besides educating communities on preventive measures and adequate hygiene practices. It is true that health interventions, like treatment of affected individuals and running of DTCs is important, but these alone will not be able to contain the spread of the outbreak in the absence of the above preventive measures.*

Source: health cluster meeting minutes

**Figure 6: Timeline of key events of the cholera outbreak, 2016-present**



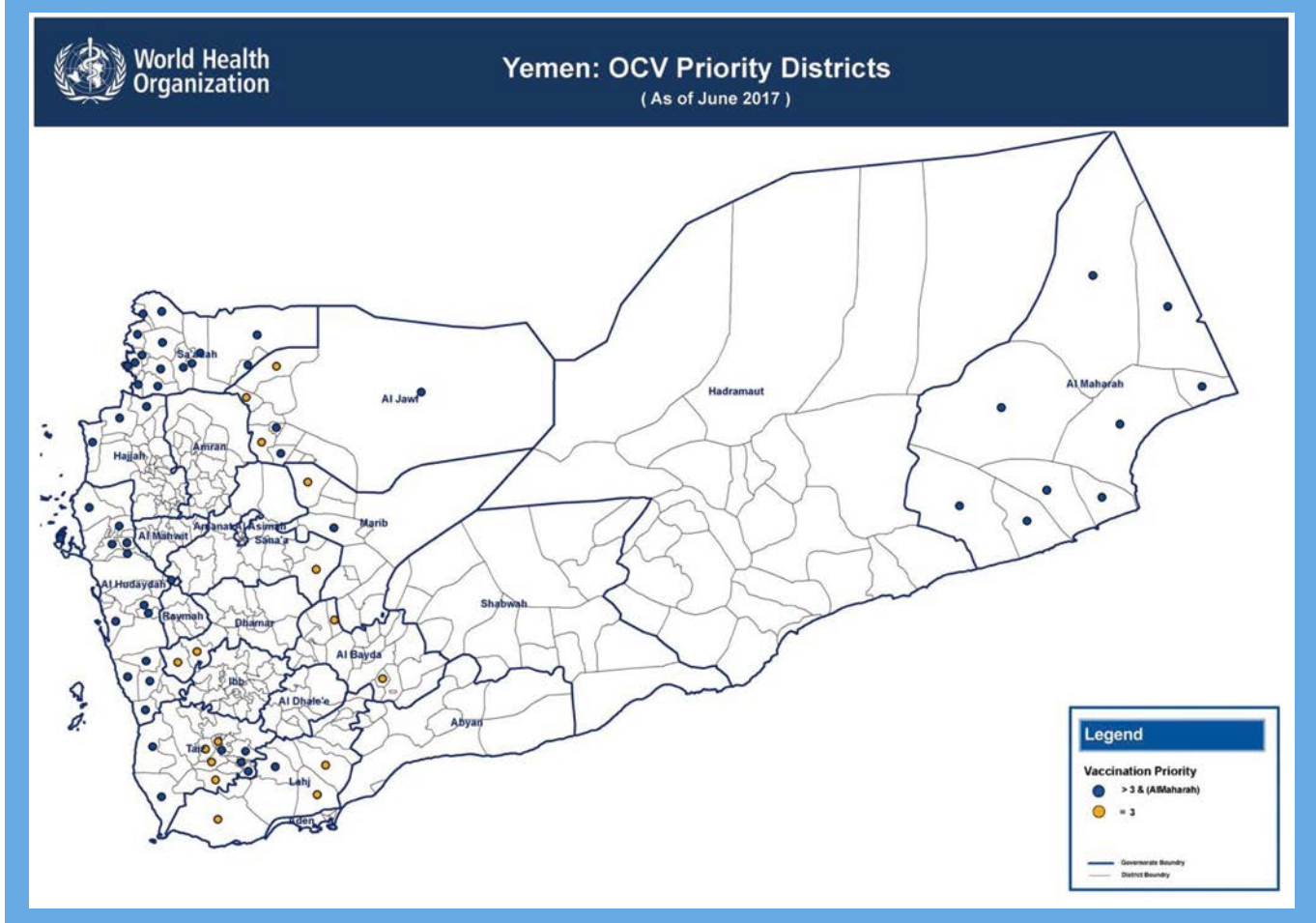
A donor voiced concerns that OCV was not being considered as a tool to reduce infection risk in unaffected populations, and there was no consideration of 1-dose strategies for short-term protection as recommended by WHO, which had been used in other insecure areas (e.g., South Sudan).<sup>37,106,107</sup> The lack of discussion among the health cluster impeded the conduct of a risk assessment, an essential component of a stockpile request, and one that requires external epidemiology expertise and a dedicated timeline to complete a sequence of tasks. There were several opportunities taken for technical assistance and knowledge transfer by the WHO country office, EMRO and WHO's Cholera Team, which proved to be constructive in due time. UNICEF's role in discussing the integration of OCV in the first wave was unclear, even though it is usually involved in supporting strategic and well-integrated use of vaccines.<sup>49,108</sup> As the caseload declined and other priorities became the focus, the political and security climate was consistently cited as not being appropriate for a campaign. Indeed, the first

integrated cholera preparedness and response plans in late 2016 did not include OCV and it was not included until July 2017, during the second wave.

### 3.7.3. EFFORTS TO USE OCV TO STOP THE SPREAD OF THE SECOND WAVE, MAY-JUNE 2017

Technical discussions on OCV among EMRO, WHO Yemen, and technical counterparts at the MoPHP continued as the second wave began. These involved bringing MoPHP senior advisors in communicable diseases and surveillance up-to-date on the evidence-base regarding the effectiveness, feasibility, and impact of OCV, and to increase their confidence in the intervention to facilitate a discussion with the MoPHP's senior management. As the rainy season and the second wave began in late April 2017, a risk assessment was undertaken with the support of an epidemiologist from the WHO Cholera Team during the peak of the second

Figure 7: Oral cholera vaccine risk assessment map for Yemen, June 2017





wave in June 2017.<sup>109</sup> Given the peak had already arrived, the assessment had a recommendation for a preventative campaign covering 3,499,905 persons in the 52 districts of the 207 with attack rates <10 cases per 100,000 population; these districts were selected based on a high vulnerability score (related to population displacement, hazards, impact, health care coverage, morbidity, nutrition, food security, WASH presence, and social determinants). These districts would receive a 1-dose strategy, requiring 3,394,907 doses, conferring protection to persons over one year of age who were not already infected (Fig 7).<sup>109</sup> Another 45 districts with the highest attack rates would receive a RRT and cholera treatment and prevention supplies without the vaccine. That same month, the MoPHP requested 3.4 million doses from the global stockpile. Some UN partners considered the plan too ambitious given the lack of operational capacity of the MoPHP. The ICG questioned the application from Yemen for not including sufficient details on the implementation plans needed to deliver such a large number of vaccines. Eventually, the ICG approved the request, with the caveat that the stockpile would supply 500,000 doses initially, with more to come as these doses were used. The MoPHP may have been dissatisfied with this response, or it may have used this demand as a reason to cancel the request for other reasons. However, the official position from the MoPHP stated after the withdrawal of the application that OCV is

“under discussion...based on scientific group decision... not a political decision and not a security decision”.<sup>110</sup>

The OCV discussions and application for the second wave stalled, likely for a combination of reasons.

### Targeting districts: data and politics

- The WHO epidemiologist conducting the risk assessment found the exercise challenging based on the perceived lack of data to guide vaccination strategies. While hotspots could be pinpointed, the accuracy of the data was in question. In addition, considerable internal displacement rendered denominators unstable;
- Some respondents voiced pressures to assure that OCV was sent to areas where the different fighting factions (Houthi-Saleh forces and Loyalists) were present. This was at odds with a data-driven, risk-based assessment of need; and
- There was a strong mistrust among some Houthi leaders and communities of vaccinations with rumors that the OCV would do harm to population. In particular, the already fragmented MoPHP (itself Houthi and Loyalists) in Sana'a were further divided on the question of OCV.

### Lack of necessary buy-in from partners

- Risk assessments are ideally participatory with the MoPHP, UNICEF, MSF, and others contributing to provide joint ownership of the results. Some respondents felt that although it is WHO's role, WHO did not include partners adequately; and
- WASH respondents stated that they were not included in the discussion of OCV, despite agreement from the WASH cluster on a vaccine option. Requests for information on WASH activities were reportedly made without adequate discussion of an integrated approach. The WASH cluster felt out of touch on the question of how to target the vaccine, and how to integrate a campaign with WASH.

*I felt there's a need to have the conversation [about OCV] in relation to preparedness planning. Agencies didn't do themselves a favor by obsessing over OCV rather than preparedness planning.*

*South Sudan, Somalia and Yemen [are similar cases]. Each country has cholera preparedness plan. We should have revised [it] and included OCV. We only wake up when there is a cholera outbreak... we always try to introduce it once the outbreak starts.*

All anonymous



### Capacity: Operationality and the global OCV stockpile

- The ICG would not have been able to provide 3.4 million doses and did not believe it would be effective, given the operational constraints. Even for countries with experience in OCV, it was difficult for the stockpile to approve 3.4 million doses (the largest shipments to date were one million doses to cover 500,000 persons in two dose campaigns in Sierra Leone in 2017 and Nigeria in 2018).<sup>111</sup> Therefore, the recommendation was to start slowly with fewer doses; and
- The effectiveness of the OCV campaign could not be ensured. Concerns were raised that the time to procure and ship the requested vaccines and then to implement the campaign would move into the rainy season. Furthermore, it was believed that a poor or compromised performance could be a reputational issue for the overall response.

This discussion was then followed by a gradual decline in caseload, with a shift to other humanitarian priorities including pre-famine conditions. The July 2017 cholera preparedness and response plan for the second wave referred only briefly to the possibility of using OCV. By that time, substantial support from WHO epidemiologists was available to support future OCV risk assessments and processes.

*In the end, [I feel] the 500,000 doses were rejected because they couldn't implement that number of vaccines and be conflict-sensitive.*

*[For OCV] WASH were always an afterthought, but then we were forced to always provide information within 1-2 hours to be ready to respond tomorrow or start with the plan tomorrow... there was no information that would be shared with us. The thinking behind the risk assessment wasn't discussed with us either.*

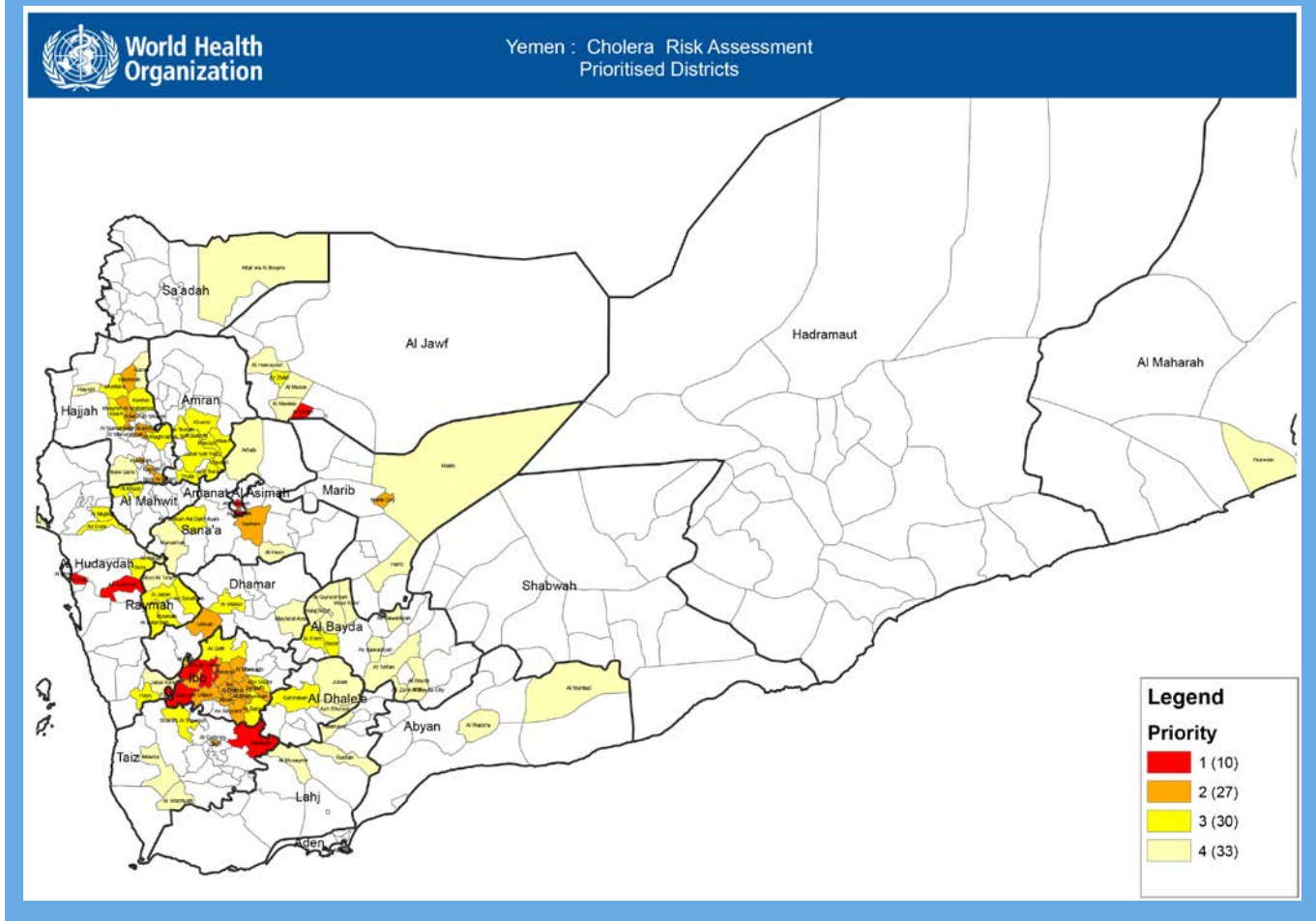
All anonymous

### 3.7.4. EVENTUAL USE OF OCV TO PREVENT ANTICIPATED ENDEMIC TRANSMISSION OF CHOLERA

Following an expert group meeting on a new risk assessment involving the WHO Cholera Team, EMRO, and WHO Yemen in Djibouti in November 2017, a risk assessment was undertaken by WHO, MoPHP, and Epicentre in January 2018 with the aim to boost prevention efforts for an anticipated surge of cholera during the rainy season between April to August 2018.<sup>112,113</sup> The risk assessment included modeling of the risk of cholera emergence across districts based on indicators of vulnerability (e.g., risk factors for infection including rainfall, access to water and sanitation and health care) and susceptibility (persons not yet immunized by infection or who had OCV). One hundred districts were recommended to be prioritized for vaccination (Fig 8).

The March 2018 cholera preparedness and response plan is the first plan that mentions an OCV strategy, based on this risk assessment. The WHO country office on behalf of the MoPHP made a successful request to the GTFCC in April 2018 for 4.6 million doses to be used for prevention as part of a comprehensive cholera control plan. The approach was validated by the GTFCC to use a 2-dose strategy to reach 2.3 million persons in the most at-risk districts for surges of cholera (Fig 13). As of May 2018, vaccination was initiated in the south (Aden, 500K doses as a first dose campaign). Respondents mentioned that there were still concerns by the MoPHP in Sana'a to move ahead with an OCV campaign. Given the intense conflict, a request was made to shift the focus in the north to a first-dose campaign in six districts in Hodeidah as well as Ibb.<sup>114</sup> Once this portion is completed, the list of high-risk districts from the risk assessment will be addressed.

The campaign in the south started slowly, but eventually reached 274,650 persons, or a first round estimate of 67.4% [95% CI 63.3–71.3] of the target population, in five districts of Aden governorate.<sup>112,115</sup> This coverage estimate is comparable to first round estimates in urban areas: Lusaka in 2016 (44%, 95% CI 40.0–49.6) and Kinshasa in 2016 (73.4%, 95% CI 62.1–80.3) [unpublished data]. The southern campaign will expand to 90 other districts throughout 2018, with a second phase anticipated in July 2018 to target 828,221 persons in Aman at al Asimah and Hodeidah.<sup>115</sup>

**Figure 13: Oral cholera vaccine risk assessment map for Yemen, January 2018**

Many challenges remain in increasing the OCV coverage in the south and beginning the OCV campaign in the north, including: extreme insecurity for some priority districts; errors in denominators given displacement; the need for effective social mobilization to increase community acceptance of the vaccine; and acceptance of the campaign by district authorities (even when Houthi authorities have given their approval for the vaccine). Finally, the ongoing airstrikes and fighting in the port city of Hodeidah as this report is being written demonstrate both the need for an OCV campaign to be undertaken as more WASH infrastructure is destroyed, as well as the very challenging operational environment for delivering mass campaigns.

In hindsight, two respondents expounded that preparedness planning for the 2018 rainy season should have been the focus across all sectors and agencies, with OCV playing a major role within that discussion. Discussions around OCV were contentious and prolonged, and other key elements of preparedness including pre-positioning supplies and various WASH interventions may have been delayed or insufficiently considered. Preparedness and response plans should have placed a premium on scenarios for OCV use, but as discussed above, the latter was not even mentioned in these plans until March 2018.



## Lessons from Yemen about adapting OCV delivery in crisis

Several factors favored the mass campaign approach in a complex humanitarian emergency:

- WHO felt that there were no problems securing operational costs for vaccine delivery, and a request had not been made to GAVI to cover those costs, as is available to GAVI-eligible countries. WHO was confident that the implementing partners had the capacity to deliver the vaccine;
- The MoPHP intended to use Yemen's far-reaching poliomyelitis vaccination infrastructure to deliver the vaccine for which WHO had recommended adaptations to suit the needs of a vaccine for all persons over one year. This has been done in South Sudan and Somalia to be more efficient and cost-effective; and
- A "first dose" 1-dose strategy with a delayed 2nd dose in accordance with WHO position on complex emergencies and as recently used in South Sudan and Zambia was agreed upon as a resourceful and effective strategy for short term protection.<sup>169,170</sup>

### 3.7.5. CONCLUSIONS AND RECOMMENDATIONS

- I) **OCV integration into national cholera preparedness plans in 'fragile' countries.** The lack of cholera preparedness in Yemen meant that OCV was not discussed formally before the outbreak occurred, nor in any response plan until March 2018, more than a year after the initial consideration. There is a need to update stakeholders across the domains of disease control, EPI, WASH, logistics, policy, and communication on the importance of OCV well ahead of a request to the stockpile in order to facilitate rapid decision-making. Somalia, South Sudan and other conflict-affected countries had similar issues to Yemen with a cholera season passing without vaccination and eventual use when the intent and logistics are clear. It is too late to begin discussions of OCV once a cholera outbreak has begun.
- II) **Improved guidance.** Given the importance of cholera in humanitarian settings, the ICG needs to develop updated operational guidance on the processes to implement OCV during an outbreak in a humanitarian setting to guide planning and response. For instance, case studies of the use of the polio infrastructure, 1-dose approaches with a delayed second dose, and means of addressing risk among displaced populations should be addressed.
- III) **Smaller, geographically targeted campaigns.** OCV campaigns that are smaller and geographically targeted have a clearer chance of succeeding in Yemen and similar contexts, given the extreme challenges with logistics and access to communities. Risk assessments should therefore prioritize high-risk areas for the first phase of vaccination.
- IV) **WHO and UNICEF coordination.** It was notable that UNICEF was not one of the leaders in the early discussions of OCV use despite their endorsement of the vaccine and highly operational role in EPI, WASH, and cholera control. This was a missed opportunity to accelerate the discussions and integrate them within a prevention and preparedness agenda.
- V) **Expedited decision-making process.** Decision-making processes in Yemen for OCV were challenged by a difficult political and operational context. However, there was insufficient coordination and communication among partners and between

WHO HQ and the WHO Yemen country team. Given its novelty and the lack of knowledge among participants, OCV discussions tended to move slowly in Yemen, which may have detracted from the important process of prevention, preparedness and response. Such an expedited process will also ensure that there is sufficient time for other interventions to be carefully considered. An expedited decision-making process on the implementation of OCV among senior government officials, WHO, UNICEF, and implementing partners needed to occur as early as possible to ensure a clear decision is made in a timely manner.

	Recommendation	Lead agency and other parties	Yemen-specific and/or future epidemics
<b>7.1</b>	Different scenarios for OCV according to varying contexts should be integrated into national cholera preparedness plans in general, and specifically for 'fragile' countries where there is a possibility of humanitarian emergencies developing or continuing.	<b>GTFCC</b> , WHO HQ cholera team, WHO regional offices, Ministries of Health	Future epidemics
<b>7.2</b>	The ICG and GTFCC needs to develop updated operational guidance on the processes to implement OCV during an outbreak in a humanitarian setting to guide planning and response.	<b>ICG, GTFCC</b>	Future epidemics
<b>7.3</b>	In complex and insecure environments like Yemen, smaller, geographically targeted OCV campaigns should be undertaken.	ICG, GTFCC	Future epidemics
<b>7.4</b>	WHO, UNICEF, the health cluster and the WASH cluster together with the government should work closely on supporting the uptake of technical and operational knowledge on delivering OCV in humanitarian settings.	<b>WHO, UNICEF, health and WASH clusters, Government</b>	Future epidemics
<b>7.5</b>	Rapid, directed workshops in targeted countries to discuss and agree upon how the risk assessment will occur in a participatory way will ensure that all stakeholders can buy into the results.	<b>WHO, UNICEF, health and WASH clusters, Government</b>	Future epidemics



### 3.8. ACUTE MALNUTRITION AND CHOLERA TREATMENT

Children with SAM have 5 to 20 times higher risk of death compared to well-nourished children.<sup>118</sup> Because of the pathology of a SAM child, treatment of co-morbid cholera and SAM requires specific attention.<sup>119</sup> For example, there are complications for which these patients are at high risk (e.g., hypoglycemia, hypothermia, sepsis, and heart failure) of which health care workers may not be aware. The assessment of SAM is difficult because the signs of dehydration, including low skin turgidity, sunken eyes, and lethargy, can also be signs of malnutrition.<sup>18</sup> Therefore, experience is needed to assess hydration status in these children. The risk of complications in children with moderate acute malnutrition (MAM) is lower, and treatment of comorbid MAM and cholera focuses only on fluid management.

#### 3.8.1. THE SCALE OF THE CO-MORBIDITY OF SUSPECTED CHOLERA AND ACUTE MALNUTRITION IN YEMEN

Prior to the onset of conflict, the global acute malnutrition (GAM) prevalence amongst children 6 to 59 months was estimated to be 16%.<sup>120</sup> During the first wave, it was estimated that almost half of the country was at risk of famine, and there were insufficient numbers of treatment facilities for acute malnutrition.<sup>121</sup> At the end of the first wave, most of the country had a serious (10-14%) to critical ( $\geq 15\%$ ) prevalence of GAM and high food insecurity. Table 3 shows that many governorates with high attack rates for suspected cholera were also affected by high prevalence of SAM. Several respondents mentioned that children with acute malnutrition were never identified as such and left untreated, partially due to the lack of CHVs to conduct outreach and screening. From January to October 2017, the nutrition cluster reported that the minority (43%) of children requiring SAM treatment received it (167,340/385,842).<sup>122</sup>

*Rehydration of severely dehydrated SAM children is difficult, since the capacity of these children to absorb liquid is hampered and they can quickly get over-hydrated. At the same time, they are at risk of dying due to shocks, if they do not receive enough fluids in a short time. ReSoMal is not recommended for children with SAM either with suspected cholera, or with 'profuse' watery diarrhea, because of the need to keep up with stool sodium losses.*

ACF, describing difficulties in the treatment of children with SAM and suspected cholera during first wave

*We came late to the game. By the time we had the materials ready (Aug 2017) the caseload had declined already... We should have recorded the cases on SAM and suspected cholera: The field was overwhelmed already with standard work and reporting. Now in retrospect, we have no data, not even basic/simple data on this.*

NGO staff member

#### 3.8.2. RECOGNITION OF THE SAM-CHOLERA ISSUES AND ITS RESPONSES

Throughout the outbreak, there was no systematic data collection system endorsed by the MoPHP for registering cholera-SAM cases in DTCs and ORCs that would enable their detection, management and monitoring. Twenty-nine percent of the suspected cholera cases were under five years.<sup>13</sup> Although there is limited data available on co-morbidity of cholera and SAM, it is likely that a high proportion of children with suspected cholera also suffered from SAM. For example, Hodeidah had high cholera attack rates and an estimated 8 to 10% SAM prevalence during the second wave (see Table

3). ACF reported that 8% of children under five years had co-morbid SAM (as measured with MUAC < 115 mm; two-thirds were suspected cholera [moderate to severe dehydration] and the remaining were AWD) in their DTC in Hodeidah city from October 28, 2016 to February 28, 2017.<sup>48</sup> ACF remarked, “At the moment of

this cholera outbreak, Yemen was facing a critical food insecurity situation, with prevalence of both GAM and of SAM higher than WHO emergency threshold (GAM  $\geq 15\%$ ). In this context, it was not surprising that many of the children admitted to the DTC presented with both dehydration and SAM of around 8%”.<sup>48</sup>

**Table 3. Attack rate, SAM and Food insecurity per governorate**

Governorate	Population	Cumulative AR (first and second waves) (%) <sup>13</sup>	SAM prevalence children 6-59 months <sup>131</sup>	Food insecurity level (March 2017 <sup>132</sup> May 2017 <sup>133</sup> )
			Est. Prevalence March 2017 (%)	
Al Mahwit	760 725	8.45	2-3%	crisis
Al Dhale'e	753 361	6.46	2-3%	crisis
Amran	1 529 834	6.84	3-8%	crisis
Sana'a	1 250 811	6.33	1-2%	crisis
Hajjah	2 474 661	5.00	3-5%*	emergency
Hodeidah	3 345 560	4.89	8-10%	emergency
Abyan	611 303	4.75	3-5%	emergency
Dhamar	2 121 016	4.95	2-5%	crisis
Al Bayda	770 151	4.48	1-2%	crisis
Amanat Al Asimah	3 308 478	3.19	3-5%	crisis
Raymah	633 758	3.03	2-3%	crisis
Al Jawf	648 754	2.49	3-5%	crisis
Lahj	1 052 545	2.42	3-5%*	emergency
Aden	956 667	2.37	2-3%	crisis
Ibb	3 065 230	2.33	2-3%	crisis
Taizz	3 059 408	2.28	2-8%	emergency
Marib	359 586	2.03	3-8%	crisis
Sa'ada	890 273	1.20	3-8%	emergency
Al Maharah	162 385	0.72	3-5%	stressed
Shabwah	646 685	0.23	3-10%	emergency
Moklla	799 268	0.07	5-8%	crisis
Say'on	668 880	0.00	5-8%	crisis

Notes: Data from March 2017 shared by NCC from Yemen during global nutrition cluster partners meeting on 30 June 2017.

Across the response, the lack of the systematic detection and registration of the co-morbidity prevented having any indication of scale and blocked the appropriate management of these patients. The recognition of the problem was delayed. According to respondents, many agencies did not integrate nutrition in their cholera response and it took efforts within and between organizations to link the health and nutrition sectors on this issue. This was partly due to that fact that few

organizations had experience with the co-morbidity. In July 2017, the CDC initiated a call through the Global Nutrition Cluster with, amongst others, the health cluster coordinator and nutrition cluster coordinators from Yemen and Somalia, global health cluster and global nutrition cluster coordinators, and WHO specialists to discuss the need and the plan for improved protocols on SAM and cholera and more evidence-based guidance.<sup>126</sup>



### 3.8.3. WHEN AND HOW WAS TECHNICAL GUIDANCE PROVIDED ON TREATMENT OF SUSPECTED CHOLERA IN A CHILD WITH SAM?

Global and national technical guidance on the management of SAM cholera co-morbidity from the UN agencies, INGOs, clusters and Ministries of Health in the countries with this co-morbidity (notably in the Horn of Africa) varied in clarity and accuracy and was not coherent.<sup>119</sup> For example, guidance on how to diagnose SAM in a child with cholera, and on preventing, recognizing, and managing specific SAM-related risks such as hypothermia, hypoglycemia, sepsis, and heart failure was often missing.<sup>119,127,18,128</sup> Indications for ORS and IV rehydration were not always clearly defined, and protocols stipulated different doses for ORS and IV rehydration. Most protocols did not recommend appropriate antibiotic treatment for cholera and SAM or AWD.

During the first wave, the comorbidity was not raised in nutrition cluster meetings from October 2016 – May 2017.<sup>129</sup> Well into the second wave in June 2017, it was discussed for the first time at the community-based management of acute malnutrition working group of the nutrition cluster.<sup>130</sup> It was agreed that WHO and UNICEF would develop a short summary on cholera-SAM management and that the MoPHP would provide MUAC tapes for screening and ReSoMal (with lower sodium and higher potassium content than standard ORS) for treatment of SAM cases without profuse diarrhea.

In July 2017, WHO, UNICEF, and the MoPHP published a two-page guidance note on fluid management for children with cholera and SAM in English and Arabic.<sup>131</sup> It did not mention risks and management of complications specific for SAM children (i.e., hypothermia and hypoglycemia). The guidance recommended to alternate ORS with therapeutic milk F75, a product used to treat SAM. Nutrition partners were asked to conduct trainings on this issue as soon as possible and contact governorate health officers directly for supplies. As a complement, UNICEF Yemen developed operational guidance for the MoPHP on practical actions to ensure identification, quality care and monitoring of children with both SAM and cholera.<sup>132</sup> This guidance explicitly stated that all children in ORCs and DTCs should be screened for acute malnutrition and those diagnosed as co-morbid SAM and suspected cholera needed immediate transfer to a DTC (and should not be treated at ORC level). It was agreed that combined SAM/suspected cholera cases at ORC level would be seen as complicated cases and therefore

*There was no special treatment for SAM cases, due to the fact that screening was not done and staff lacked experience in management of SAM during cholera outbreak.*

NGO staff member

*As a lesson learned, one thing we are going to be very clear on, from 2018 onwards at least is that children under 5 get screened (in a cholera outbreak), the anthropometric measure MUAC is taken and children are categorized by SAM.*

UN staff member

needed referral to DTCs. The combined use of therapeutic milk F75 and ORS was recommended only if a therapeutic feeding center (TFC) was in the same location as the DTC.

This core guidance was produced as the outbreak declined during the second wave. A UN respondent stated that “the impact was therefore not significant in the response; but helpful as preparedness for future outbreaks.” Trainings started in August 2017 (see Fig 9).

**Figure 9: Banner with guidance developed by UNICEF, MoPHP, and WHO displayed in DTCs (courtesy of Relief International)**



The cholera preparedness and response plan of April 2018 confirmed that training was still ongoing through 2018. In parallel, the MoPHP and WHO developed SOPs for DTCs and ORCs in 2017.<sup>83,133</sup> However, many respondents stated that the specific training on fluid management in SAM was lacking as was on screening for SAM.

### 3.8.4. QUALITY AND APPLICATION OF GUIDANCE AND TREATMENT OF SUSPECTED CHOLERA IN A CHILD WITH SAM

Various NGO respondents reported that they had difficulties in managing the co-morbidity as some cases were complicated, and the cholera-specific training opportunities for health care workers were limited. There was consensus among respondents that all children needed to be screened with MUAC, fluid management preceded SAM treatment, and that great caution was needed during rehydration of SAM children. The overuse of IV fluids wherein patients with mild or moderate dehydration would get IV fluids over ORS could potentially have put SAM children in DTCs at additional risk (see case management section). Despite the formal guidance, according to many respondents, screening for MUAC in ORCs or DTCs was not systematically carried out in the facilities they organized. This meant that children with SAM that presented at ORCs with suspected cholera were likely not transferred to DTCs. Various NGOs found the guidance useful, but insufficiently concrete on how to conduct the fluid management. Some NGOs tried to find other guidance from other countries and/or developed their own or placed temporary experts in their DTCs; for example, one NGO placed a pediatrician (on ad-hoc basis) and/or CMAM nurse in a DTC to deal with suspected cholera in SAM children.

Though the official guidance recommended to alternate ORS with therapeutic milk F75 in the DTCs, there was reportedly no F75 available in the majority of DTCs. According to respondents, different reasons for the lack of F75 included:

- MoPHP was the designated agency to provide F75 but did not request it from UNICEF;
- MoPHP did not allow F75 in the DTCs, and thus F75 was only available in TFCs;
- There was overall insufficient supply of F75 in-country;
- There were no cooking facilities in the DTCs; and
- MoPHP did not allow food to be prepared in DTCs.

### *Dilemma – where to treat SAM after discharge from a DTC?*

*One NGO stated that many of the nutritional services had collapsed in Yemen already before the first wave and that there were very few alternatives other than treating SAM already in the DTCs. Though the health authorities pushed for scaling up stabilization centers for the treatment of SAM after discharge from a DTC, the NGO nor the GHO/DHO had enough resources to do this. This caused a dilemma for the NGO who then must discharge a child with SAM with no good referral center. The NGO created a nutrition corner within the DTC to closely monitor SAM children and provided SAM treatment alongside fluid management.*

Source: Internal report from NGO on Lessons Learnt, April 2017.



Various NGOs wanted to start SAM treatment with F75 within the DTCs because of anticipated problems in TFCs:

- The quality of nutritional care in many existing TFCs was low because of unpaid salaries and lack of staff;
- The number of TFCs was relatively low compared to the high number of children with SAM. In addition, NGOs were not always allowed to set up additional TFCs and there were areas where the government could not work either;
- Some TFCs were no longer accessible because insecurity; and
- There were limited supplies in TFCs to provide the adequate treatment for SAM.

Even if the SAM child with suspected cholera was stabilized in DTCs, there was not always a place to refer a child to for additional SAM treatment (see box). Whether or not to use F75 in DTCs became controversial and partners disagreed amongst themselves. The formal guidance issued by MoPHP/UNICEF/WHO stated to use F75 in the DTC, but UNICEF's operational guidance for MoPHP stated that F75 was to be given only if a TFC was in the same place as the DTC. According to various NGO respondents, the MoPHP did not support treatment of SAM as such in DTCs, however the formal guidance the MoPHP co-authored suggested that the use of nutritional products for SAM were recommended in DTCs. Many DTCs did not have a TFC nearby. This caused a dilemma for many practitioners as there were limited options which drove NGOs to use F75 in their DTCs:

- Obtain supplies of F75 and start treatment in DTCs (though supplies were limited and this was not favored by the MoPHP); or
- Refer a child with SAM who was discharged at a DTC to a TFC that was very far and/or had limited level of care.

*First response was only Health and WASH; for our NGO it took time to realize that also nutrition was involved; we did not have much experience in this comorbidity. I was learning whilst doing and a colleague from East Africa (Somalia) helped.*

NGO staff member

Although guidance was clear on the use of ORS for suspected cholera, it is not clear from respondents or nutrition cluster minutes whether this was well managed. Many children who came to ORCs and DTCs with AWD or cholera and would have needed either ReSoMal (AWD) or low osmolality ORS (cholera or profuse watery diarrhea) if they had SAM. But as many were not screened for SAM, it would have been difficult to provide the correct treatment. The key to proper management was detection and documentation, but the patient cards used in DTCs were not adapted to register and address suspected cholera/SAM co-morbidity, and there were no specific patient cards for children. The CDC, endorsed by the nutrition cluster, had provided a newly designed patient card (that combined general cholera treatment as well as SAM related information) to the health cluster coordinator, various NGOs and UNICEF in August 2017; the main objective of the cards was to enable monitoring of treatment and outcomes.<sup>134</sup> As patient cards had just been printed, however, most DTCs did not use the adjusted version. One NGO printed the CDC version with MoPHP (see Annex 5).

An important gap in UNICEF Yemen's operational guidance document was to transfer a malnourished child to a TFC after two days of initiating treatment with antibiotics (UNICEF recommended a three-day course of erythromycin as first line of choice) (see text box). However, research indicates that after two days of treatment, 30% of children could potentially still shed *V. cholerae* through their stools, and that malnutrition is predictive for even longer shedding.<sup>135,136</sup> One NGO raised this already in July 2017 with UNICEF, WHO, MoPHP and the nutrition cluster. Some NGO staff suggested that only SAM children with culture negative stools for cholera should be transferred to TFCs; but as stool cultures were not readily available and would take an additional 48 hours, this recommendation was not followed. The SOPs



that were developed mid-2017 by WHO and MoPHP were not updated despite agreement by all agencies that MUAC screening would take place at ORC and DTC level.

### **ACTION: Transfer the children with SAM and Cholera from DTC to OTP or TFC**

The child is rehydrated, stabilized and ready to be transferred back to OTP or TFC when the child is no longer infective (after 2 days of initiating treatment with antibiotics) and there are signs of adequate rehydration.

Source: *Operational Guidance UNICEF Yemen July 2017*<sup>140</sup>

### **3.8.5. INFANT AND YOUNG CHILD FEEDING (IYCF) AND CHOLERA IN YEMEN**

Overall, in Yemen prior to the cholera outbreak the exclusive breastfeeding rates were very low (10%)<sup>120</sup> and therefore many humanitarian actors were already actively addressing IYCF. The nutrition cluster also had a working group on IYCF. When the outbreak started, practitioners were concerned that lactating women would stop breastfeeding due to a fear of cholera transmission; this was an unsubstantiated fear. Some NGOs stated that many were using therefore breastmilk substitutes or cow's milk. Specific guidance on suspected cholera and breastfeeding were led by Save The Children and MoPHP and managed through the IYCF working group at the height of the second wave. UNICEF's cholera toolkit already provided the response with substantial materials for promoting IYCF in a humanitarian context and cholera.<sup>18</sup>

Throughout the outbreak, various IYCF trainings took place based on comprehensive IYCF guidance though it was limited on young child feeding.<sup>134</sup> The operational guidance that UNICEF provided to the MoPHP was useful but not always consistent. For instance, it stated that it is often necessary during an outbreak to interrupt temporarily breastfeeding if a mother is infected; yet in the same document it states, 'A mother with cholera should continue breastfeeding as long as she is conscious, even while receiving intravenous fluids' and 'mother and baby should remain together to enable the

mother to breastfeed her baby (the baby should be fed on demand)'. Guidance on support to non-breastfed infants was not addressed by MoPHP/UNICEF. In order to support infants and breastfeeding women, one NGO used lactation counselors within the DTC to ensure good practice. Some respondents stated that despite good guidance there was often not enough physical space for breastfeeding corners in DTCs.

### **3.8.6. CONCLUSIONS AND RECOMMENDATIONS**

- I) The treatment of suspected cholera in children with SAM** needs specific attention because of potential additional complications and the high prevalence of SAM in Yemen. The majority of organizations and DTCs did not take into account complications with SAM patients until late into the second wave of the outbreak (mid-2017). The need for specific case management and additional guidance was raised late after the first wave and did not materialize in Yemen until mid-2017. Even then, the guidance was insufficiently practical and coherent for practitioners and reflected the lack of clarity from global normative agencies and bodies.
- II) Supervision:** In many ORCs and DTCs where guidance was available, it was not followed (e.g., no screening for SAM or use of F75).
- III) Surveillance of SAM:** The scale of children with suspected cholera with SAM was and remains unknown. However, many governorates with high attack rates for suspected cholera were also affected by high prevalence of SAM.
- IV) Most guidance materials** that were developed and trainings that were rolled out are now regarded as part of a preparedness plan for another wave of endemic cholera.



	<b>Recommendation</b>	<b>Lead agency and other parties</b>	<b>Yemen-specific and/or future epidemics</b>
<b>8.1</b>	As early as possible, develop and agree on a standardized protocol for the screening and treatment of suspected cholera cases with SAM and where this should take place. This guidance must also address the discharge of SAM patients from a DTC for further treatment whilst minimizing the risk of infecting other children.	<b>WHO, UNICEF, Government</b>	Yemen-specific and future epidemics
<b>8.2</b>	Improved supervision of health care workers and provision of sufficient means to allow them to follow protocols and provide the correct treatment and referral, despite the challenging operational context, is needed in Yemen. This could be achieved through a training of trainers' approach and monitoring and review of care using data collected through the enhanced patient cards.	<b>WHO, UNICEF, Government</b>	Yemen-specific and future epidemics
<b>8.3</b>	Cholera preparedness and response plans need to consider contexts with high burden of acute malnutrition and suspected cholera and take into account issues related to protocols, data, health infrastructure, expertise, and materials. As part of such a preparedness plan it is important to explore further the need of adjusted patient monitoring forms.	<b>WHO, UNICEF, Government</b>	Yemen-specific and future epidemics

### 3.9. CROSS-CUTTING ISSUE: COMMUNICATION AND SOCIAL MOBILIZATION

Given the poor accessibility to communities and considerable disconnection between communities and the institutions meant to provide services, the need for effective communication and social mobilization around the cholera outbreak was paramount. Social mobilization is a cross-cutting issue as it is meant to promote treatment and hygiene promotion, provide IEC materials, as well as to eventually provide support for the OCV campaigns when they were instituted.

UNICEF staff explained that IEC materials were initially directed toward two focused goals: (1) to encourage people who were symptomatic to present to health facilities as soon as possible (likely to support their survival and to reduce community transmission), and (2) encourage preventative actions like household hygiene. Several respondents discussed shortcomings of the IEC materials, but also stressed that they covered the main issues in a technically-sound and culturally appropriate manner.

Respondents frequently underlined that severe insecurity made it difficult to organize community services including social mobilization. The most significant community engagement strategy used face-to-face messaging and IEC materials during August 2017. Six to eight weeks into the second wave, the July 2017 cholera preparedness and response plan attempted to address more community-level interventions through UNICEF's direct mobilization of community volunteers (including CHVs, Imams, midwives) to disseminate health messages and engage with religious leaders and families, and conduct household level WASH interventions. A national house-to-house awareness campaign in which 40,000 volunteers supported by mobile teams covered cholera awareness messages across 14M households in all 23 governorates occurred from August 15 to 30, 2017.<sup>137</sup> This was a massive undertaking supported by WHO and UNICEF. Several respondents commended these efforts, but also expressed the need to do this earlier during the second wave.

Delays may be related to the fact that the use of existing community health networks (e.g., MoPHP community health volunteers (CHV) focused on nutrition, NGO-supported community health workers (CHWs), and YRCS health volunteers) were fragmented. Through their natural role in social mobilization, CHVs could also support referral, ORC management, and surveillance. However, this remained a difficult issue due to the need for training at a massive scale and to assure adequate

quality of services. As discussed by UNICEF staff: “We used them where they could deliver, which was hygiene promotion and awareness raising”. However, since the conflict had exacerbated already poor access to health facilities in rural and remote areas, CHVs were already being used to augment service delivery by extending primary care to remote settings including treatment, hygiene promotion, and chlorination campaigns near the household.<sup>138</sup> During the cholera outbreak, their services were intended to be extended through support for the World Bank’s Emergency Health and Nutrition Project.<sup>139</sup> However, several interviews with health coordinators of INGOs found there was a lack of integration of CHVs into surveillance activities, though support to social mobilization for cholera, delivery of ORS and Aquatabs, and suspect case referral, was supposed to be a standard part of the CHV package. UNICEF staff stated that it was unclear how best to use CHVs for surveillance given that the existing problems with the precision of the application of the case definition and the risk of inflating the suspect number of cholera cases further without sufficient training and monitoring. The solution was to use CHVs to signal apparent clusters of cases and deaths to rapid response teams for follow-up (“event-based surveillance”).

### 3.9.1. CONCLUSIONS AND RECOMMENDATIONS

- I) **Organization of community networks:** CHVs supported separately by MoPHP, YRCS, and UNICEF were not mobilized under a single program to offer consistent social mobilization, referral and surveillance activities.
- II) In preparation for future epidemics, Governments, UNICEF and its partners have a major role in registration of CHVs, and **supporting mass trainings** as well as **supervision** of CHVs across these systems.

	Recommendation	Lead agency and other parties	Yemen-specific and/or future epidemics
9.1	A single program for consistent social mobilization, referral and surveillance activities should be mobilized for CHVs.	<b>UNICEF, Government</b>	Yemen-specific and future epidemics
9.2	Registration of CHVs, and supporting mass trainings as well as supervision of CHVs across these systems needs to occur in preparation for future epidemics.	<b>UNICEF, Government</b>	Future epidemics

### 3.10. CROSS-CUTTING ISSUE: INSECURITY AND ITS EFFECTS ON THE CHOLERA OUTBREAK

By any measure, the war in Yemen has taken a devastating toll on civilians. 44,000 violent deaths have been documented since 2016 (not including deaths indirectly resulting from conflict, malnutrition-related deaths, and cholera deaths)<sup>140</sup>, two million persons are internally displaced<sup>142</sup>, and 61% of the population is food insecure and at-risk of famine<sup>142</sup>. Airstrikes affecting civilians, recently killing a busload of 40 children, continue in 2018.<sup>9</sup> In addition, the physical damage to the civilian infrastructure caused by civil war and heavy warfare is a constant threat to public health.<sup>144</sup>

Both the progressive degradation of civilian infrastructure and social services in Yemen and the acute destruction of infrastructure have required the humanitarian system to rethink how best to provide aid in a protracted conflict and how to address a rapidly expanding cholera outbreak in this extremely constrained context. At the current time, war in Hodeidah is putting half a million persons at risk and threatening the flow of aid, food, and key goods at the port.<sup>143</sup>

While not a comprehensive description of the security and operational context in Yemen, the purpose of this section is to describe: (a) the extremely constrained context for cholera response; (b) man-made factors which have likely contributed to transmission; and (c) the means by which to address these factors. To do so, we have categorized security-related risk factors for cholera transmission into four categories:

- Airstrikes on water and sanitation infrastructure in the north;
- Attacks on health care workers and health facilities;
- Closures of ports, airports, and blockades of imported food, fuel, medications, and medical supplies; and
- Artillery fire, movement- and goods-restrictions.

#### The Burden of war in Yemen in 2018

- 44,000 violent deaths (2016-)<sup>60</sup>
- 85 airstrikes killing 1,000 civilians<sup>61</sup>
- Two million IDPs<sup>62</sup>
- 61% (17.8M) of population food insecure<sup>62</sup>
- 50% of health facilities functional<sup>7</sup>
- 30,000 health workers unpaid since 2016<sup>62</sup>
- 23 attacks on health facilities (Oct 2017-May 2018)<sup>62</sup>
- 71 ICRC staff evacuated (2018)<sup>62</sup>
- 3 billion USD requested for aid<sup>61,63</sup>

#### 3.10.1. AIRSTRIKES ON WASH INFRASTRUCTURE IN THE NORTH AND ATTACKS ON HEALTH WORKERS AND HEALTH FACILITIES

A contributor of the worsening of transmission of cholera is the destruction of water and sanitation systems due to SLC airstrikes, and their subsequent ineffectiveness in providing safe water. The damage caused by airstrikes has been documented by the Yemen Data Project and Human Rights Watch.<sup>141,145,146</sup> These airstrike data can be used to assess the timing, location and extent of damage and suggest that airstrikes were associated with the damage to WASH and health infrastructure between April 2015 and December 2017<sup>145</sup> (Fig 10):

- 74 reported instances of damage to water-related infrastructure;
- Extensive damage to desalination plants reported in Taiz, Hodeidah, Hayz, and Al Mukha;
- Damage to water bottling plants and Coca Cola factories;
- 70 reported instances of targeting of health facilities; and
- Damage to four cranes used to move goods in the Hodeidah port.<sup>147</sup>

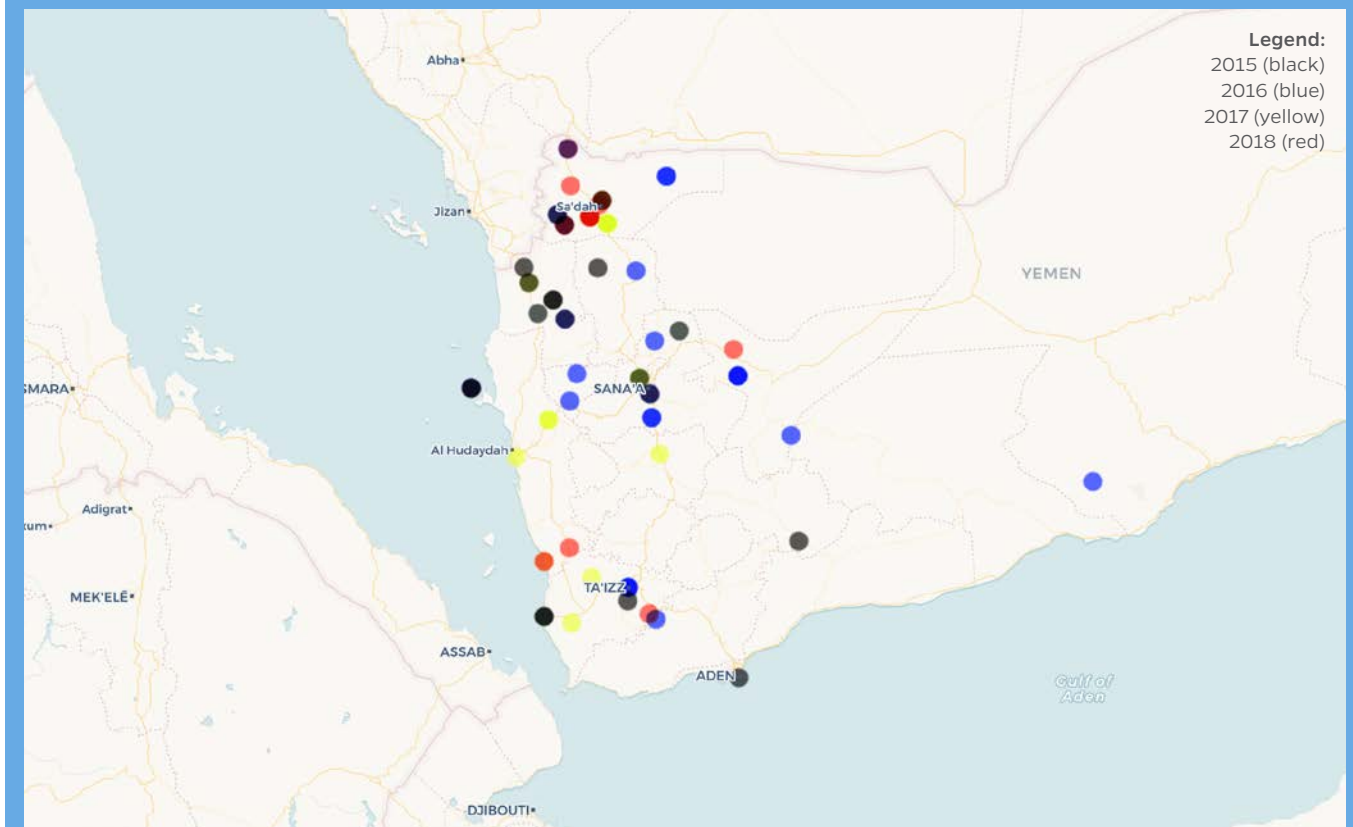
**Fig 10: Locations of airstrikes targeting water infrastructure, 2015-2018** (Source of data: Yemen Data Project)<sup>65</sup>

Fig 10 demonstrates that airstrikes on civilian water and sanitation infrastructure have continued throughout the conflict, despite repeated calls for the protection of these sites. Three examples from as recently as July 2018 illustrate the problems of airstrikes targeting civilian infrastructure:

- UNICEF strongly condemned repeated airstrikes from March to July 2018 on a large water facility in the Nushour area of Sa'ada, an area under Houthi control.<sup>148</sup> This is the third attack in five months on the same facility; it was attacked twice in one week in March 2018. According to a statement from UNICEF: “more than half of the project is now damaged, cutting off 10,500 people from safe drinking water”. The attack incurred extensive damage to the solar power system, pump, and storage tank, resulting in hundreds of thousands of dollars of damage;
- Comprehensive airstrikes in late July 2018 damaged a set of key infrastructure in Hodeidah including a health facility, laboratory, sanitation infrastructure, and a water station which supplies the water to the city.<sup>142</sup> Save the Children reported in October 2018 a 170% increase in suspect cases following this damage to WASH facilities; and <sup>149</sup>
- In June 2018, an early morning airstrike hit a marked DTC run by MSF in Abs, destroying a ward and the triage (Fig 11).<sup>150</sup> The facility was marked clearly on its roof and its coordinates were shared with the SLC for deconfliction purposes. It was located close to the Abs Rural Hospital. MSF then pulled out its staff from Abs.



It is not possible to directly correlate airstrikes with water access by governorate in this descriptive study, however, a report by REACH found that both, (a) In some surveyed governorates, access to infrastructure *increased* during the conflict, as humanitarian actors provided fuel and rehabilitated systems, and (b) in some surveyed governorates, access to infrastructure *decreased* due to lack of fuel, not air strike damage and in some governorates, access to infrastructure *decreased* due to air strike damage.<sup>151</sup> The report continued by stating that “the needs of households not connected to public piped network are met by an unregulated private sector, through tanker-trucks, carts with tank and bottled water”.<sup>151</sup> Surveys show that 30% of the population now pays for water (up to 81% in Sana’a) and in 7 of 20 surveyed governorates more people rely on trucking than piped network water. The report concluded that “the efforts of humanitarian partners have contributed to maintaining (or in some cases even improving) access to the piped water network. However, supporting the operation and maintenance of these networks is costly, and requires flexible and reliable funding to continue this activity. If this support would not be available, people in these governorates would likely shift from piped water network to a paid or unimproved water source. Therefore, efforts to operate and maintain the existing water infrastructure should continue.”

There is currently no government funding or salaries for the operation of water supply and sanitation systems. Several respondents reported that such extensive infrastructure damage is difficult and costly to repair, and that a humanitarian donor would overrun its budget quickly if it were to keep up with the repairs needed. Some of this damage may have been inadvertent and associated with military activity near these sites. However, the ongoing pattern of repeated strikes on water infrastructure, including several desalination facilities, suggests that these sites were purposefully targeted as part of the SLC military campaign.

Several instruments, including an international legal framework for air and missile warfare and the Geneva Conventions are readily available to prevent this from happening.<sup>153</sup> The purposeful destruction of civilian water infrastructure is a violation of several international agreements. Protocol I (Geneva Conventions, Additional Protocols, 1977) already provides special protection for “objects indispensable to the survival of the civilian population.” This protection is most clearly delineated in paragraphs two and three of Article 54, which state: “It is prohibited to attack, destroy, remove or render useless objects indispensable to the survival of the civilian population, such as . . . drinking water installations and supplies and irrigation works, for the specific purpose

**Fig 11: Airstrike damage incurred DTC in Abs, June 2018; Abs DTC in July 2017<sup>70,72</sup>**



of denying them for their sustenance value to the civilian population or to the adverse Party, whatever the motive.” Paragraph three goes on to state: “The prohibitions in paragraph two shall not apply to such of the objects covered by it as are used by an adverse Party [as “sustenance solely for members of its armed forces” or “in direct support of military action”] ... provided, however, that in no event shall actions against these objects be taken which may be expected to leave the civilian population with such inadequate food or water as to cause its starvation or force its movement.”

Other global agreements have also elevated civilian water systems as protected objects. For example, attacks on civilian water infrastructure are also considered to be a violation of the right to an adequate standard of living, as stated in the International Covenant on Economic, Social and Cultural Rights (Article 11), the UN General Assembly’s Human Right to Water, and in the United Nations Watercourses Convention of 1997.<sup>154</sup> The United States accepts as customary international law the prohibition against intentionally targeting objects indispensable to the survival of the civilian population, including water installations, foodstuffs, crops, and livestock. However, this prohibition has not been generally extended to other forms of infrastructure that may in fact be crucial to the operation of water systems, particularly electricity generation and distribution systems. For example, US and Coalition forces struck the electric grid early in the First Gulf War (Operation Desert Storm), a tactic that was considered to have “helped reduce Iraq’s ability to respond to Coalition attacks.”<sup>155</sup> However, this also had a dramatic reverberating impact on civilian populations, including on essential water, sanitation, and health capabilities.

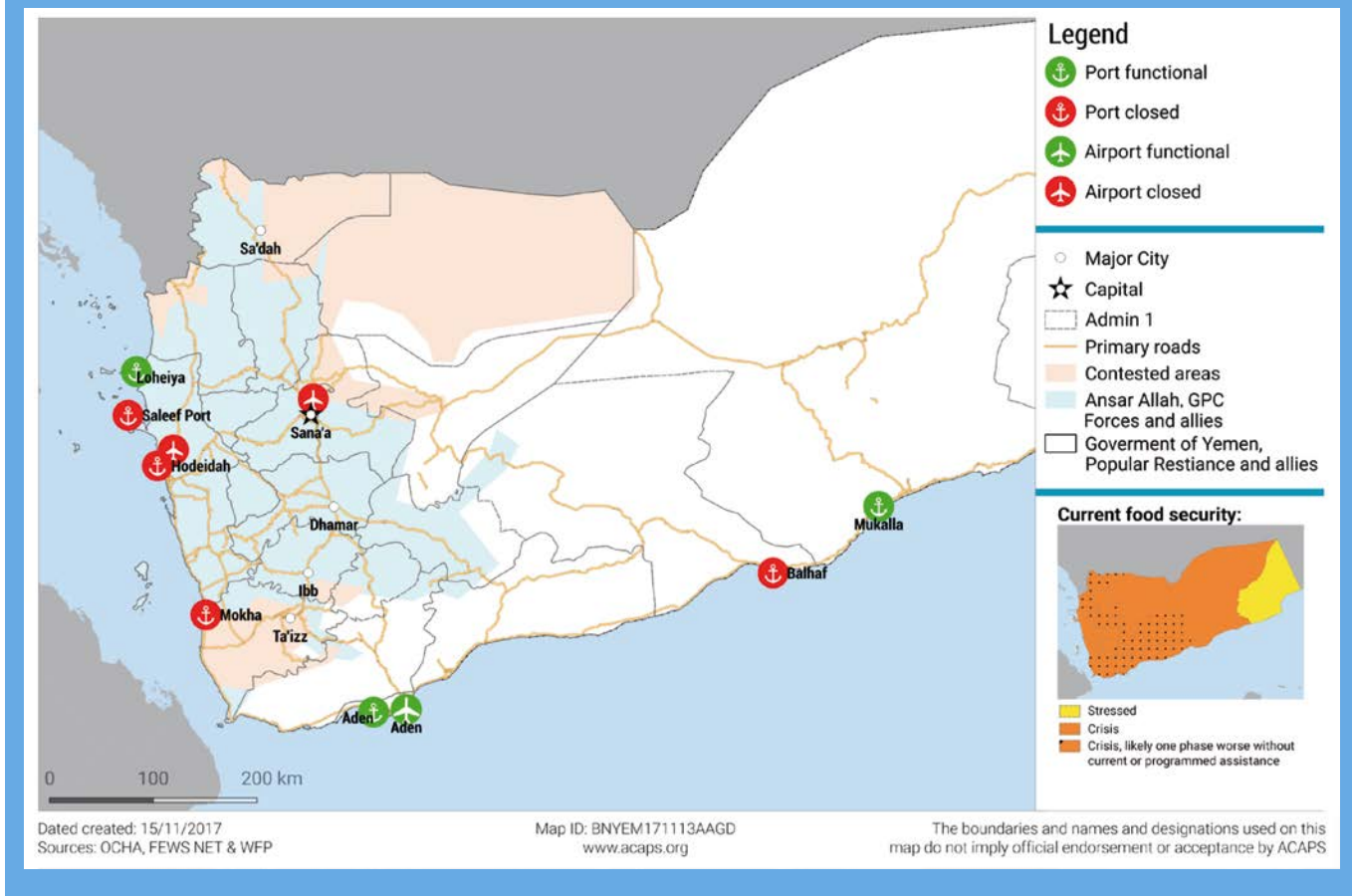
The destruction of electric and related infrastructure is generally permitted if such facilities are deemed of military necessity. Nevertheless, such attacks would need to meet accepted criteria of proportionality, a principle that demands that combatants not inflict damage to noncombatants that is excessive in relation to the military advantage associated with an attack (such as an airstrike).<sup>156</sup> Yet, this proportionality principle has been criticized as vague and inherently unable to protect infrastructure that has both a military and civilian, therefore, dual use.

In the case of Yemen, proportionality considerations for dual use installations have not provided much protection, even when the apparent military importance is greatly outweighed by the survival interests of civilian populations.<sup>157</sup> Only the SLC’s internal Joint Incidents Assessment Team conducts post-strike investigations, though these have not addressed how they decide which strikes to investigate and what actions are taken as a consequence to improve the protection of civilians in further pre-strike analyses.<sup>141</sup> It is notable that OCHA’s deconfliction role with the SLC clearly aids in avoiding inadvertent strikes on the UN and its partners in both static and mobile locations.

### 3.10.2. CLOSURES OF PORTS, AIRPORTS, AND BLOCKADES OF IMPORTED FOOD, FUEL, AND MEDICAL SUPPLIES

In retaliation to rockets fired by Houthi-Saleh forces at Riyadh, in November 2017 the SLC closed the majority of seaports, airports, and land crossings (Fig 12).<sup>158</sup> Ports in government controlled areas were opened shortly after, though in the north they remained closed. This had the immediate effect of halting the flow of goods to 27 million persons who are reliant on the 80 to 90% of food, fuel, medicine, and other key goods that are imported into Yemen. There was an immediate impact on humanitarian aid, which affected cholera: WHO and UNICEF reported the blockage of 250 metric tons of medical supplies and water purification tablets via the Hodeidah port, and temperature-sensitive vaccines.<sup>158</sup> In addition, MSF and ICRC’s planes were also blocked at the airports.<sup>158</sup> NGOs found the blockade to be detrimental to their procurement processes, noting however, that international procurement was already taking four months of lead time.

Even at present, arrangements to permit humanitarian and medical supplies to pass through the blockade have apparently been inadequate, haphazard, or associated with significant time delays (three to five days between arrival an anchorage and berthing).<sup>158</sup> Despite the challenges of airstrikes on port facilities in Hodeidah, partners are making significant efforts to pre-position cholera supplies to prepare for the cholera response in the conflict-affected city.<sup>114</sup>

**Fig 12: Closure of seaports, airports and land crossings, November 2017** (source: ACAPS)<sup>78</sup>

### 3.10.3. ARTILLERY FIRE, MOVEMENT- AND GOODS-RESTRICTIONS

As with most instances of civil conflict, data on events relating to ground-level skirmishes and restrictions of movement and aid by warring parties are difficult to document. Respondents reminded the study team to also account for the fact that aid was at the hands of district-level warring parties. Various reports and respondents cited the restrictions at the district level, as being problematic to the cholera response. Indiscriminate firing into Taizz and Aden has created an insecure operating environment. The blocking of food and medicines, and restriction of the movements of aid and humanitarian workers has likely affected the speed of the cholera response.<sup>141</sup> At least one NGO reported being unable to open a DTC due to the lack of assurances of its safety.

### 3.10.4. CONCLUSIONS AND RECOMMENDATIONS

**Protection of Civilian Infrastructure:** The destruction of civilian infrastructure including water systems and desalination plants is likely a major contributor to the maintenance of the infectious ecosystem of cholera in Yemen. In addition, the targeting of transportation and port infrastructure has caused major disruptions in the cholera response. The indirect effects on the attacks of dual use (civilian and military) infrastructure such as bridges, electric generating and port facilities, including the emergence and obstructed response to infectious outbreaks, can persist over long periods of time. These effects on civilian populations can dwarf any military necessity associated with the strike. Improved coordination between humanitarian actors and combatant forces appears feasible and may help with deconfliction involving civilian infrastructure including

health and water and sanitation infrastructure as a matter of course (and not just focus on the movements of humanitarian partners). Improved evacuation and deconfliction capabilities would also facilitate growth in the numbers of humanitarian workers permitted in the Yemen theater of operations. The following recommendations are broad in nature and necessarily at a higher level to protect civilians in Yemen now as well as future complex emergencies.

	Recommendation	Lead agency and other parties	Yemen-specific and/or future epidemics
10.1	Attacks on dual use (civilian and military) infrastructure such as bridges, electric generating, and port facilities should be considered with extreme caution given the poor state of civilian infrastructure and inability to pay for and repair infrastructure.	<b>UN humanitarian country team</b> , in particular OCHA (for advocacy to warring parties)	Yemen-specific and future epidemics
10.2	Attacks on water and sanitation infrastructure should be terminated. The UN should adopt a strong stance on the protection of both health facilities and water and sanitation infrastructure by sharing the locations with the SLC and monitoring attacks. At a global level, WHO uses a system to document attacks against health facilities. This system can be operationalized at the national level to proactively to include locations of health facilities and water and sanitation systems to include in pre-strike analyses, and to monitor attacks against these systems.	<b>UN humanitarian country team</b> , in particular OCHA (for advocacy to warring parties)	Yemen-specific and future epidemics
10.3	Analysis of the potential and actual effects of an airstrike is a key component of warfare, and should be committed to, to avoid continuously harming civilians and civilian infrastructure.	<b>UN humanitarian country team</b> , in particular OCHA (for advocacy to warring parties)	Yemen-specific and future epidemics



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### 3.11. CROSS-CUTTING ISSUE: COORDINATION

A coordination structure that incorporates the multiple sectors and organizations involved in cholera control is the backbone of an effective response.<sup>18</sup> Countries that experience endemic cholera often have pre-existing coordination structures in place. Yemen had not experienced cholera for many years, and had to rapidly assemble a coordination structure. It is notable as well that coordination needed to include two governments, as the Yemen government was officially divided. Respondents found working with the two governments an “incredible challenge that was unlike any other setting” due to their political disagreements and the vacuum of technical over political counterparts.

The cluster system was already in place before the cholera outbreak began in September 2016. The L3 emergency, airstrikes, and the extremely constrictive operational environment triggered additional coordination mediated by OCHA, namely, the deconfliction of movements with the SLC and the

*In Yemen, we can't simply turn the ship around. A child dies of malnutrition and [another] child dies of cholera. But they are both dying. What's an appropriate way to get the funds we need and make it available [for both malnutrition and cholera control]?*

Donor

screening of imported goods by the UN Verification and Inspection Mechanism (UNVIM).

Cholera coordination efforts in Yemen were placed within the remit of the health cluster (led by WHO) and the WASH cluster (led by UNICEF), with technical support from a national CTF, and eventually the implementation of the IMS led by WHO. All three systems operated at various times with various success and limited complementarity (Table 4).

**Table 4: Cholera Coordination Mechanisms in Yemen, October 2006 to present**

Mechanism	Stated Role <sup>22,80</sup>	Actual Role	Leadership	Members	Establishment
Clusters (national and sub-national)	<ul style="list-style-type: none"> <li>Coordinate activities of humanitarian organizations</li> <li>Information sharing</li> </ul>	As stated. Develop technical guidelines and standards	WHO (health) UNICEF (WASH) UNICEF (nutrition) WFP (logistics)	Humanitarian organizations and MoPHP	<ul style="list-style-type: none"> <li>Existed before cholera</li> </ul>
Cholera Task Force (national and sub-national)	<ul style="list-style-type: none"> <li>Develop strategies to guide cluster response</li> <li>Developing technical guidelines and standards</li> </ul>	Develop preparedness and response plans	MoPHP	MoPHP, WHO/EOC, UNICEF, health and WASH clusters, MSF	<ul style="list-style-type: none"> <li>National CTF (Oct 2016)</li> <li>Sub-national CTFs (unclear)</li> </ul>
Incident Management System/ Emergency Operations Centers	<ul style="list-style-type: none"> <li>Data processing</li> <li>Facilitate team work</li> <li>Plan for different stages of the response</li> <li>Assign roles and responsibilities</li> <li>Prioritize tasks</li> </ul>	Data processing at district level Information sharing Hub for Rapid Response Teams	WHO	Humanitarian organizations and MoPHP	<ul style="list-style-type: none"> <li>National EOCs (Sana'a, Aden) established in June 2017</li> <li>5 governorate EOC established by March 2018 (Amran, Ibb, Hodeidah, Hajjah)</li> </ul>
Rapid Response Teams (health, WASH)	<ul style="list-style-type: none"> <li>Health: Rapid local investigation, sample collection, response, and monitoring</li> <li>WASH: household based response within first 48 hours</li> </ul>	As stated.	WHO (health) UNICEF (WASH)	Not applicable	<ul style="list-style-type: none"> <li>331 health RRTs by April 2018 (per district)</li> <li>248 WASH RRTs (at governorate level; deploy to districts)</li> </ul>



### 3.11.1. CLUSTER COORDINATION

Yemen's need for strong coordination remains paramount given the extensive humanitarian responses necessitated by complex emergency and the two governments. Effective coordination of a cholera response depends on contextual factors which dictate whether coordination should be government or cluster-led, and technically- or operationally- focused.<sup>18,70</sup> For example, in Zimbabwe and Iraq, a Cholera Command and Control Centre (C4) was used.<sup>21,70</sup> The C4 operated within the clusters and provided coordination for operational units in provinces and cities. This separated the role of the cluster from cholera coordination. The C4 also had working groups to provide technical guidance.<sup>21</sup>

In Yemen, the cluster approach organized humanitarian responses among organizations, shared information, identified gaps, and advocated for partner needs and funding. It was expected that individual clusters would provide operational support to strategic plans developed by the CTF (ex., logistics, resource allocation, dissemination of technical guidance, and the capacity building and training of partners).<sup>18</sup> The health and WASH clusters were considered best suited for coordinating cholera activities, as they had existing relationships with the government(s) and partners, and could situate the response within the existing operational environment and geographical distribution of partners. The clusters showed agility in coordinating the initial response through a humanitarian lens. For instance, the clusters rapidly developed the initial cholera preparedness and response plan.<sup>49</sup> They played a major role in securing the import of supplies for partners via WHO, UNICEF, and the World Food Program (WFP). These tasks may have been delayed if taken on by a newly created entity, that would need to develop relationships and a strategy from the ground up.

Respondents generally viewed the health and WASH clusters as effective for cholera coordination and implementation. Respondents believed the strong personal relationship between the cluster leads drove this synergy and there was concern expressed about both cluster leads leaving before the anticipated endemic surges in cholera in 2018. Despite the relationship, there were predictable initial tensions around roles, and concerns about how some issues that straddle WASH and health were managed, including IPC and OCV. As in other humanitarian response settings, there were tensions among the agencies, particularly at the senior

levels of WHO and UNICEF in-country, that negatively affected cluster coordination. Many respondents stressed this particular issue, which included mistrust, blaming others for insufficient performance, and a lack of data sharing.

Other challenges to the cluster approach emerged. First, from the start of the first wave, staff from the health and WASH clusters took the lead in strategic planning and technical guidance for cholera on top of the heavy workload of coordination of the humanitarian response. The health and WASH clusters drafted the first and second wave response plans and the epidemiological

*Bringing everybody to the table to actually make critical decisions on strategy, especially around the key things where there are a WASH and health overlap, I think that those discussions just never move forward quick enough.*

Senior WASH staff

*UN agencies bringing in supplies was really useful. NGOs were on the frontline. Trying to get Ringers and ORS and buying in local market and couldn't find that any more. Then WHO or UNICEF contracted with NGOs to bring stuff in.*

Donor

*[The cluster] felt that the more you do prevention activities (hygiene kits, IEC materials, hygiene promotion, chlorination of wells, WASH in general)...the more you can reduce the caseload.*

Senior Health Cluster staff (first wave)



projections of morbidity, mortality, and the duration of the outbreak. This was done with the input of cluster members who were familiar with cholera, but the process and the assumptions used could have benefited from more input from external technical specialists in cholera, outbreak control, and epidemiology from a CTF and/or WHO and UNICEF regional or headquarter experts. The strict limitation on the number of international staff who could enter Yemen due to security constraints limited the depth of the planning at this stage. However, numerous respondents across agencies at different levels stated that the clusters and the governments could have taken on board the advice from cholera experts throughout the outbreak, particularly from WHO and UNICEF. The cluster-based planners of the initial response plan focused strongly on large-scale prevention in areas not yet affected by cholera and provision of case management. This approach was used instead of an aggressive detection, investigation, and response strategy in high-risk areas to reduce secondary transmission. The wide-ranging approach was soon recognized as unfeasible, as system-level interventions could not be implemented quickly or at scale, and many areas were too insecure to reach (while treatment and outreach worked better in the accessible areas). There was also inadequate consideration of OCV as an early strategy to reduce risk in high risk areas affected by conflict. The WHO Cholera Team in Geneva, EMRO, and some donors advocated to start the OCV assessment process shortly after the first cases were confirmed. Nonetheless, OCV was not mentioned as a strategy until the third preparedness and response plan that was created during the second wave (July 2017) (see OCV section).

Second, the health cluster could not officially coordinate directly with two major health partners, MSF and ICRC. While their self-exclusion is standard, it is an important gap in Yemen, as MSF and ICRC undertook a large proportion of the case management activities, they had their own security protocols, transport, and infrastructure, and had the most experience with cholera care. The health cluster also operated with little information management support throughout both waves, and thus the preparation of coordination bulletins that displayed the data from the outbreak, gaps and needs was limited. Consequently, their intention to provide adequate and timely updates for monitoring and modifying interventions accordingly often outstripped their capacity.

The 2015 to 2018 former Humanitarian Coordinator for Yemen remarked that in retrospect, the response should have been centralized in the Humanitarian Country Team earlier to ensure a more multi-sectoral and integrated response. During the second wave, he made moves to ensure that the coordination of the response went beyond the health and WASH clusters. It is worth noting that the Inter-Agency Standing Committee (IASC) procedures to designate a large-scale outbreak as an L3 emergency were enacted in 2013, and could have been evoked here at an early stage to develop a more intersectoral coordination structure.<sup>160</sup>

### 3.11.2. NATIONAL CHOLERA TASK FORCE

The role of a Cholera Task Force (CTF) is to provide strategic and technical decision-making, establish standards and guidance, provide advocacy for resources and establish monitoring activities.<sup>18</sup> In October 2016, the MoPHP established a national CTF with WHO, UNICEF, health and WASH clusters, and MSF, with an aim to establish sub-national CTFs (although the latter did not appear to materialize). The stated objectives of the CTF were to discuss strategic issues that would guide cluster partners, provide technical guidance, and communicate regularly with clusters and governorate health offices. However, several respondents were confused about the role of the CTF and referred to the CTF and clusters interchangeably. One health cluster respondent stated that the CTF tended to focus on operations. Most often in large outbreaks including cholera in Haiti, and Ebola in West Africa, the CTF branches into a series of technical working groups that provide technical support and generate guidance across major technical areas (ex., WASH, case management, and laboratory). However, in

*EOC have staff from MOH [including] epidemiologists. EOCs can look around, see what's happening and get activities done on the ground. [But] coordination is still going through clusters. EOCs are good as a surveillance unit for response using surveillance data [to drive RRTs]*

Anonymous

Yemen, the CTF did not have technical working groups or generated timely guidance. This likely contributed to the late appearance of standard operating procedures across sectors which, as a consequence, the clusters produced.

### 3.11.3. OTHER TECHNICAL ASSISTANCE

There were several serious challenges to assuring technical assistance. Respondents stressed that technical advice from WHO and UNICEF on crucial topics ranging from OCV to laboratory protocols to decentralization of the response was not often taken into account through the MoPHP, governments, or the CTF. The response was remote with respect to programs and beneficiaries in many senses: regional and country staff for many agencies were based in Amman, and those who were in Yemen were based in Sana'a or Aden with frequent travel out of Yemen for trainings, meetings, and recuperation. Experienced cholera epidemiologists and WASH implementers could not arrange for visas or entry in a timely manner (see WASH and OCV sections). It follows that high-quality technical advice for cholera response was delivered remotely from the HQs of institutions. Many respondents stated this approach was difficult as experts could not directly observe programming, train staff, and have face-to-face working relationships with implementers. The lack of a means of providing timely and robust technical support remotely to oversee the technical aspects of the cholera preparedness and response plans is an important oversight. In other settings like South Sudan, for example, cholera-specific trainings in secure locations have been delivered to frontline staff and technical advisors. Respondents did not highlight specific means by which WHO, UNICEF, and the clusters delivered technical assistance to partners apart from the distribution of protocols and tools. However, the UN presumably would have the same issues of lack of consistent access to field sites faced by partners.

Communication and decision-making choices are challenging in every emergency, and Yemen was no exception. Respondents mentioned tensions between WHO HQ cholera experts who provided advice to WHO Yemen but did not believe the advice was sufficiently followed (e.g., from the implementation of OCV to surveillance including this use of RDTs and culture) as well as challenging coordination and communication issues between WHO and UNICEF at country level. Some of these issues likely negatively affected the ability to

## Views on IMS

*EOC is necessary to move from classic coordination response toward sharing resources, planning and moving together.*

*There were five [sub-national] cluster hubs. What about the UN presence in other places? Inception of IMS/EOC was a big push to get RRTs from health and WASH to work together in these places where there was nothing else.*

*I think when you have a national disaster response framework and a country that's very well prepared, you know a command and control model works very well. But it is very dangerous because it's counteractive to a collaborative approach, which is basically how the clusters work.*

*A must-have in an IMS system is a mandate, and that didn't happen in Yemen.*

*There is confusion on role of CTF vs. cluster vs EOC, and overlap on roles. CTF was meant to focus on strategy and guidelines but discussions focused on operations, same as EOCs.*

*All the discussion in Yemen has been about EOCs (i.e., just the rooms) but little about IMS (role of persons in EOCs, authority, who reports etc).*

All anonymous



better integrate WASH and health response, as well as other sectors.

### 3.11.4. INCIDENT MANAGEMENT SYSTEM AND EMERGENCY OPERATIONS CENTRES

By the peak of the second wave in June 2017, WHO Yemen and the MoPHP introduced another mechanism, the incident management system (IMS) and its network of emergency operations centers (EOC). This reflects recent global efforts by the WHO to implement more predictable responses for health emergencies including outbreaks, through an IMS that integrates the government and other partners into a unified command structure.<sup>161</sup> The IMS aimed to “adopt a more operational posture by reducing the number of meetings and increasing the face-to-face working of the relevant stakeholders” as compared to the “information sharing forum” of the cluster system.<sup>162</sup>

WHO’s use of IMS in health emergencies is relatively new. WHO first initiated IMS for the 2016 yellow fever outbreak in Angola and has launched five operations since, with three in complex emergencies (Rohingya crisis in Bangladesh, displacement in Northern Nigeria, and cholera in Yemen).<sup>22</sup> A similar structure was applied by Sierra Leone and UK militaries and WHO, for the Ebola response in Sierra Leone.<sup>24</sup> However, only Yemen concerns both a conflict and a large outbreak, with many layers of existing coordination mechanisms.

IMS was implemented in Yemen in June 2017, at the start of the second wave. Twenty-two EOCs were planned for including two national EOCs in Aden and Sana’a affiliated with one health RRT per district. While WHO invested in equipping the EOCs with telecommunications, only four to five of the 22 planned were operational by the end of 2017, while seven of the planned 22 EOCs planned for April 2018.<sup>163</sup> WHO standards emphasize that the mandate and objectives of IMS need to be clear to partners from the start.<sup>164</sup> However, the mandate of the IMS – essentially the command and control structure rather than the provision of rooms and equipment – did not appear clear to respondents. The perception of some respondents that WHO introduced IMS as a solution for the initial “*weak and delayed response*” and “*the failure of clusters to coordinate*”, is contrary to its stated mandate to improve teamwork and operations.

The feasibility and timing of the implementation of IMS and a network of EOCs in a country that was at war was questioned by numerous respondents from the field-level to HQ. First, buy-in remained difficult. The IMS specialist responsible for introducing the concept was commended by respondents for starting discussions with all partners to build “*consensus across INGOs/UN/cluster system to have division of responsibility according to comparative advantage of each agency*”. However, a widely-held view was that there was not enough progress with IMS to get full buy-in from partners once it became operational. At first, agencies including UNICEF, WFP, and UNDP contributed resources, vehicles, and expertise. However, the expansion stalled due to the exit of the IMS specialist, the lack of participation of government staff from the two governments, involvement of external partners and not just the UN, and the shutdown of the national EOC in Sana’a due to threats from rebel groups. The flagship EOC had to be moved to the WHO office, which did not have enough space for all partners. This essentially rendered the EOC as a “*meeting room at WHO*”. Some respondents mentioned that power dynamics were at play with the clusters concerned about losing their influence. UN agencies were concerned that WHO was consolidating their coordination role with the government at their expense. One set of respondents simply concluded that “*it was not the right time to introduce an IMS*”.

The lack of mandate may have been compounded by a lack of a decentralized technical assistance model for the implementation of the IMS. There was little WHO HQ-driven technical assistance from the EOC Operations Team that had been provided to other systems in the past. WHO Yemen led the implementation through the IMS specialist, who departed Yemen. This led to rapid implementation without embedding a team that could provide an adequate understanding of IMS principles on the ground, training, and the interface with partners that was necessary beyond the initial discussions. This was further complicated by a lack of global guidance on how IMS and the cluster should integrate in different contexts. The IMS concept was introduced to the Global Health Cluster in 2017, and lessons are being drawn in real time about its performance in recent emergencies. As discussed by WHO, a global lesson learned to date has been that IMS is a “*way of thinking*” and more standard operating procedures, trainings, and briefings are needed to work IMS into WHO structures.<sup>22</sup> Respondents reported that there was a lack of understanding among WHO staff and EOC coordinators themselves about what IMS should accomplish. This led to respondents’ concerns that the EOCs were not actually operational whereas clusters were still taking on investigation and response through the RRTs.

Despite its shortcomings, the national EOCs in Sana’a and Aden made progress in improving the data processing and information management, and EOCs in general were cited by respondents as housing local expertise in epidemiology and case management in a unified structure. This allowed for the organization of investigation through health RRTs at a local level. They became part of the chain of command for data, aggregating and vetting the data as it was sent to the central unit. It follows that in February 2018 preparedness and response plan, EOCs were specifically listed as being epidemiological technical bodies that could analyze data routinely to direct interventions and in turn, ensure swift actions through the cluster system and its partners.

### 3.11.5. RAPID RESPONSE TEAMS

RRTs were first mentioned in the November 2016 cholera preparedness and response plan. In theory, IMS and EOCs provide a decentralized structure for basing the RRTs in the second wave. National multi-sector RRT networks combining case management, epidemiology, and WASH/logistics have been used as part of EWARS for cholera outbreaks in Haiti and elsewhere.<sup>26</sup> The main objectives of the RRTs were as follows:

- Health RRTs operated at the *community-level* to provide localized and timely investigation and sample collection, response, community-level awareness, and monitoring where the health system could not provide that function;<sup>26</sup>
- WASH RRTs focused on the *household level* to investigate and provide immediate household-based response within the first 48 hours of detection when clusters of 5 to 20 or more suspected cases were detected. The principle is that the interruption in most at-risk households and their neighbours can interrupt community transmission.<sup>99,165,166</sup> The WASH RRT also carried out rapid WASH infrastructure rehabilitation work in communities.<sup>167</sup>

Three hundred and thirty-one (331) health RRTs were established and aligned with the IMS and EOC mechanisms at the district level and 248 WASH RRTs were run by the WASH cluster at the governorate level.<sup>159</sup> Multiple respondents highlighted the RRTs as alleviating known gaps to the response including local capacity to investigate clusters of cases, early response, and quality control of the case definition and interventions. This suggests that it is critical to ensure RRTs have a context-specific set of activities to complete. A main challenge was providing a consistent, decentralized communication link between the two teams, despite the separate command lines. UNICEF most recently introduced a “control room” where health and WASH RRTs can access data immediately, discuss actions taken, and establish coordination mechanisms as the sub-national level. The impact of the cholera RRT system has not been evaluated in Yemen or globally. However, evaluation from Haiti shows its promise as an integral part of the cholera alert and response, and elimination strategies.<sup>26</sup>



### 3.11.6. CIVILIAN-MILITARY COORDINATION

OCHA provided coordination of protection of humanitarian partners through the deconfliction mechanism with the SLC, and UNVIM (see security section).<sup>168</sup> Coordination and mediation by the UN in terms of deconfliction and importing supplies for partners was important to assuring that airstrikes did not target static and moving locations of partners. UNVIM assured the unbiased review of goods imported into Yemen.

### 3.11.7. CONCLUSIONS AND RECOMMENDATIONS

**I) Coordination Mechanisms:** There was, and still is, a lack of clarity regarding the coordination systems in Yemen which has delayed and fragmented the response. The lack of clarity is reflected globally as well, in terms of the absence of technical guidance on the initiation and alignment of coordination mechanisms for health emergencies such as IMS and clusters, particularly when the latter are already functioning.

The mandates, coordination, and lines of authority regarding technical guidance and strategy development between HQ, national counterparts, and the CTF were unclear. The lack of agreement among these core coordination elements has impacted the timely development of protocols and ongoing support for the response. They caused and are still causing confusion and lack of trust among organizations. Furthermore, WHO's Emergency Response Framework<sup>161</sup> does not sufficiently address the roles, mandates, and interlinkages and coordination among the IMS and clusters.

A cholera outbreak of this magnitude and complexity should not be led and coordinated by the health and WASH clusters, as was initially the case. Analogous to the West Africa Ebola outbreak or the C4 structure in other national cholera outbreaks in Iraq and Zimbabwe, a broader systemwide response should have been triggered. This is illustrated by the important logistics and procurement issues which slowed the scale-up of a rapid response, and the omission of input on pre-famine and systems-wide issues of other key clusters including nutrition and early recovery, in the earliest phases of planning. Since Yemen was already declared an L3 emergency before the cholera outbreak, the L3 activation procedures for infectious disease events could have activated a more coherent coordination structure which tied together the humanitarian system and technical aspects of disease control.<sup>160</sup>

**II) Decentralization of Coordination and Response:** In Yemen, a lack of decentralized coordination and response was a major impediment. There were few sub-national clusters, EOCs were implemented in only 8 of the 22 governorates, and the sub-national CTFs were not implemented as intended.



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	<b>Recommendation</b>	<b>Lead agency and other parties</b>	<b>Yemen-specific and/or future epidemics</b>
<b>11.1</b>	<p>The mandates, roles, and reporting lines of the clusters, CTF and IMS urgently require clarification, harmonization, and agreement by the government(s) and partners. This should be discussed using a facilitated process between partners to evaluate their current roles, identify areas of complementarity, and gaps in coordination. Mandates and roles can then be established without redundancy.</p> <ul style="list-style-type: none"> <li>Coordination mechanisms should incorporate options for decentralized coordination as has been done for cholera and Ebola in other contexts.</li> <li>Decentralized hubs that bring together human resources and functions of the sub-clusters, IMS, and CTF could be implemented in a clear and concerted manner to avoid duplication, which would likely have enabled the quicker implementation of decentralized RRTs, data processing, monitoring, and supervision.</li> </ul>	<b>WHO, UNICEF, cluster system, Government(s) of Yemen, INGO partners</b>	Yemen-specific
<b>11.2</b>	Continue the health-WASH inter-cluster meetings.	<b>Health and WASH clusters</b>	Yemen-specific
<b>11.3</b>	The CTF should be revitalized and should include a focus on the technical aspects of the cholera preparedness and response plan, developing protocols for the case management of high-risk groups, and technical issues for surveillance and laboratory systems.	<b>CTF members, Government(s) of Yemen</b>	Yemen-specific
<b>11.4</b>	<p>According to the WHO's Emergency Response Framework, to ensure a clear mandate, IMS should have been implemented toward the beginning of the epidemic, much earlier than during the peak of the second wave. Therefore:</p> <ul style="list-style-type: none"> <li>The mandate for IMS needs to be clarified urgently, with less emphasis on assuring physical structures such as EOCs and more clarification on how the command and control structure of IMS works in conjunction with the health and WASH clusters and external partners outside of WHO.</li> <li>Modifications to IMS functions should be considered in Yemen (e.g., filling gaps in terms of information management, supervision of health RRTs).</li> </ul>	<b>WHO, Government, IMS partners</b>	Yemen-specific and future epidemics
<b>11.5</b>	<p>WHO HQ should define the range of tasks that the IMS aims to fill apart from the standard tasks undertaken by a strong cluster system.</p> <ul style="list-style-type: none"> <li>Based on emerging experiences across humanitarian contexts, WHO HQ should develop guidance as to how the various response and coordination mechanisms (e.g., IMS, clusters) can work together in a complementary manner with clear lines of authority in different contexts.</li> </ul>	<b>WHO HQ EOC operations team, WHO HQ health emergencies branch, global cluster system</b>	Future epidemics
<b>11.6</b>	To ensure best practices, the introduction of IMS should be continuously supported by technical expertise from WHO HQ or the regional offices.	<b>WHO HQ EOC operations team, WHO HQ health emergencies branch, WHO Regional Offices</b>	Future epidemics
<b>11.7</b>	<p>When an epidemic is starting during a declared L3 emergency, a decision-making process to centralize the response within the Humanitarian Country Team should be considered at the earliest stages possible.</p> <p>The rationale is the early development of a well-resourced multi-sector effort with technical input from WHO on disease control.</p>	<b>UN humanitarian country team, WHO</b>	Future epidemics



	Recommendation	Lead agency and other parties	Yemen-specific and/or future epidemics
11.8	Decision-making should include other sectors/clusters including nutrition and early recovery when addressing food insecurity, SAM, and the need for system-wide improvements to water and sanitation; this is especially apparent in contexts of high acute malnutrition and pre-famine/famine conditions.	<b>WHO, UNICEF, health and WASH clusters</b>	Future epidemics
11.9	<p>In a large-scale cholera outbreak in a crisis-affected country with few decentralized public health resources, health and WASH rapid response teams should be implemented as quickly as possible to support early investigation and response.</p> <ul style="list-style-type: none"> <li>As a large set of RRTs were eventually implemented, it stands that they could have been created earlier (as was suggested by the first wave plans).</li> <li>Consider the relative advantages and disadvantages of merging the health and WASH RRTs, which has been done in other contexts such as South Sudan.</li> </ul>	<b>WHO, UNICEF, Government</b>	Future epidemics



### 3.12. RECOMMENDATIONS FOR UPDATED STANDARDS AND RESEARCH

Throughout the report, there has been much reference to various standards, guidance and research.

Below is a list of the recommendations.

	<b>Recommendation</b>	<b>Lead agency and other parties</b>	<b>Yemen-specific and/or future epidemics</b>
<b>12.1</b>	Improved protocols for surveillance and laboratory monitoring of outbreaks, including the systematic use of RDTs and cultures where laboratory capacity is lacking: <ul style="list-style-type: none"> <li>▪ Guidance for implementing OCV during an outbreak in a humanitarian setting;</li> <li>▪ Standards and protocols for the treatment of SAM with cholera; and</li> <li>▪ Standards and protocols for the treatment of pregnant women with cholera.</li> </ul>	<b>GTFCC</b> , ICG (for OCV implementation)	Future epidemics
<b>12.2</b>	Standardized cholera outbreak tools including standardized case definitions, line-lists, data analysis and processing plans, and data flow schematics should be developed at the global level by the GTFCC and made readily available to countries.	<b>GTFCC, WHO HQ</b> (“Outbreak toolkit”, a project in progress at WHO)	Future epidemics
<b>12.3</b>	Protocols for remote monitoring of epidemics, including key indicators	<b>Global health cluster</b> (Public Health Information Standards)	Future epidemics
<b>12.4</b>	Research on: <ul style="list-style-type: none"> <li>▪ The effectiveness, package of interventions, and process and procedures carried out by health and WASH RRTs;</li> <li>▪ Effectiveness of treatment protocols for cholera among pregnant women;</li> <li>▪ Optimizing the package of OCV and WASH in field settings to improve long-term prevention of cholera; outcomes and impacts of combining WASH and OCV interventions;</li> <li>▪ Improving the sensitivity and specificity of RDTs; and</li> <li>▪ Developing and evaluation in austere settings different and simpler techniques for the culture of cholera at the field level with options for transport that reduce degradation.</li> </ul>	<b>GTFCC</b> (to advocate), WHO, UNICEF	Future epidemics

## 4. CONCLUSIONS

Studying the cholera outbreak response in Yemen has made clear to the study team the extensive efforts required to respond to cholera rapidly and at scale during an L3 emergency. The multitude of political, security, cultural, and environmental barriers clearly restricted the scope for effective cholera prevention and control. We commend the government, INGOs, NNGOs, and donors for trying to find solutions in this difficult context. There are no easy fixes to these challenges, and the conclusions and recommendations in this case study are meant to be constructive and practical, taking into account the extremely constricted environment. We acknowledge that partners have carried out intensive work to optimize the response after the end of the second wave. We hope this report is useful for further improving the cholera response in Yemen and similar contexts.

The case study has important limitations. Despite our efforts, we were unable to visit Yemen and observe practices first hand. Also, the turnover of key staff between the 2016 and 2018 made an evaluation of the larger picture of preparedness and response difficult to assess.

Nonetheless, the findings were consistent across respondents and methods. The study team found that several areas gained strength throughout the second wave, including: an extensive operational footprint which reached into insecure areas despite the constrained context; the strengthening of the collaborations between WHO and UNICEF and the health and WASH clusters; the initiation of a funding mechanism through the World Bank which enabled a timely response at scale; the revitalization of the WASH strategy; and, eventual consensus and use of OCV.

Conversely, the major gaps of this response are rooted in weaknesses in preparedness and the early strategies developed in the first wave. First, the conflict and history of cholera in Yemen and the region should have triggered a strong focus on epidemic preparedness. Pre-planning should integrate: scenario planning for OCV; protocols for laboratory reinforcement in peripheral areas; the judicious stockpiling of supplies; assuring WASH-cholera and case management capacity among INGOs and NNGOs; reinforcing networks for community-based surveillance; referral and social mobilization; and, decentralizing RRT support, all in peripheral areas. An after-action review after the first wave could have institutionalized these aspects in order to prevent a much larger second wave.

Second, the surveillance system in a complex emergency should be primed for outbreak detection and response and additional laboratory capacity should be added to support culture confirmation. Third, the WASH strategy should have focused on cholera rather than generalized programming. Fourth, given the severe insecurity and remote context, the decentralization of community-based approaches to treatment, referral, and WASH should have been an early strategy. Finally, coordination structures were unnecessarily confusing with the mandates, roles, and reporting lines of the clusters, CTF, and IMS overlapping and incompletely developed. The lack of harmonization across these areas seriously hampered management, technical output, and trust between agencies. IMS should have been implemented at the beginning of the epidemic, or at least much earlier than during the peak of the second wave. Global guidance and standards from WHO for IMS application with the cluster system and during existing emergencies is needed.

It should be noted that while funding for epidemic preparedness globally is lacking, funding for the cholera response in Yemen was not.<sup>169</sup> An important positive step for Yemen has been the World Bank's support to the response which was instrumental in rapidly disbursing funding and improving coordination between WHO and UNICEF in Yemen. The World Bank's commitment to supporting the UN and its partners in crisis-affected countries, and the specific need for preparedness in Yemen, provide the rationale for major investment in bolstering the preparedness activities in conflict-affected and fragile state contexts which would go far for addressing the foundational gaps discussed in this case study.<sup>77,169</sup>







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## ANNEX 1: ABOUT THE STUDY TEAM

**Nora Hellman** is a registered nurse with an MPH who has worked for International Medical Corps and Save the Children's emergency health teams where she supervised healthcare workers and provided patient care after natural disasters and during conflict. She has also undertaken outbreak responses for yellow fever in Democratic Republic of Congo, Ebola in Liberia, and cholera (managing CTCs) in Haiti and South Sudan.

**Daniele Lantagne** is a public health engineer who has worked for the Centers for Disease Control and Prevention, London School of Hygiene & Tropical Medicine, Harvard University, and Tufts University to reduce the burden of infectious diseases by investigating and evaluating the effectiveness of water and sanitation interventions in low-income countries and emergencies. She has provided technical assistance and completed research in over 50 countries.

**Moise Ngwa** is an Assistant Scientist at the Johns Hopkins Bloomberg School of Public Health. He has a PhD in Public Health from the University of Florida. At the Emerging Pathogens Institute, he conducted research on cholera in Haiti and Cameroon. Since 2017, he has been working with the DOVE Project at JHCHH on operations research and monitoring and evaluation of oral cholera vaccine programs in Cameroon and Malawi.

**Ruwan Ratnayake** is a field epidemiologist who has worked primarily for the Health Unit of the International Rescue Committee and with WHO to assess health in emergencies and respond to outbreaks. This includes cholera in South Sudan and Haiti, Ebola in Sierra Leone, health assessment in South Sudan and Iraq, and with UNICEF, efforts to integrate the oral cholera vaccine into preparedness planning in West and Central Africa.

**Paul Spiegel** is a physician and the Director of the Center for Humanitarian Health at the Johns Hopkins Bloomberg School of Public Health. He is internationally recognized for his research on preventing and responding to complex humanitarian emergencies. Previously he held posts at UNHCR (Deputy Director of Programme Management and Support Services; Chief, Public Health and HIV Section), CDC (Medical Epidemiologist) and the Médecins Sans Frontières (Medical Coordinator).

**Mija Ververs** is a nutritionist, Senior Associate with the Center for Humanitarian Health at Johns Hopkins Bloomberg School of Public Health, and Health Scientist/Senior Nutritionist at the Emergency Response and Recovery Branch at CDC. She has over 30 years of field experience in public health, nutrition, and food security, across organizations including ICRC, IFRC, international NGOs, and the UN. She currently focuses on guidance for the management of cholera and acute malnutrition.

**Paul Wise** is a physician, Professor of Pediatrics and Health Policy, and a Senior Fellow in the Center for Democracy, Development and the Rule of Law and the Center for International Security and Cooperation, in the Freeman-Spogli Institute for International Studies, all at Stanford University. He leads a multidisciplinary initiative, Children in Crisis, which integrates expertise in political science, security, and health services in civil conflict and unstable governance.

## ANNEX 2: ORGANIZATIONS INTERVIEWED

1. Action Contre la Faim: Paris and Yemen
2. Canadian Red Cross/Yemen Red Cross Society
3. CARE: Yemen
4. Centers for Disease Control and Prevention (CDC)
5. Center for Civilians in Conflict (CIVIC)
6. WASH cluster: Yemen
7. Department for International Development (DFID)
8. European Civil Protection and Humanitarian Aid Operations (ECHO): Amman
9. Epicentre
10. International Rescue Committee: Emergency Response Team and Yemen
11. General Authority for Rural Water Supply Projects (GARWSP)
12. Health cluster: Yemen
13. Human Rights Watch: Middle East office
14. International Committee of the Red Cross: Geneva
15. International Medical Corps: Washington and Yemen
16. Médecins Sans Frontières – Netherlands/OCA
17. Médecins Sans Frontières – Barcelona/OCBA
18. Nutrition cluster: Yemen
19. The Office of U.S. Foreign Disaster Assistance (OFDA): Amman
20. OXFAM: Oxford and Yemen
21. Relief International
22. Save the Children: Emergency Response Team
23. SOUL: Yemen
24. UNICEF: Public Health Emergencies Team, WASH Team, Health Team, Nutrition Team, Middle East and North Africa Regional Office (MENARO), Yemen Country Office
25. United Nations Humanitarian Coordinator: Yemen
26. United Nations Office for the Coordination of Humanitarian Affairs: Riyadh
27. World Bank
28. World Health Organization: Director of Emergency Operations, Cholera Team, Emergency Operation Centre Operations Team, Emergency Risk Management and Humanitarian Response Team, Health Emergency Department of the Eastern Mediterranean Regional Office (EMRO), Yemen Country Office



## ANNEX 3: EVOLUTION OF CHOLERA RESPONSE STRATEGY IN THE FIRST AND SECOND WAVES (ND = not discussed)

Date	Persons at risk; projected number of cases; estimated duration	Goals	Coordination mechanisms	Surveillance interventions	Laboratory interventions	Case management interventions	OCV
<b>Oct 2016</b>	7.6M in 15 governorates at risk - 6 cholera confirmed or suspected - 9 high risk with proximity or risk factors - Estimated duration of 3-6 months	Blanket Health, WASH, and C4D cholera response across 15 governorates; emphasizing improving surveillance, opening DTCs, central laboratory, WASH, C4D, cholera task forces	Led by Governorate Health Office (GHO); National and subnational cholera task force (CTF); support from clusters	Case definition <b>ND</b> Reliance on eDEWS. Community surveillance and rapid response teams mentored.	Support to central laboratory; decentralization <b>ND</b>	DTC scale-up plan <b>ND</b> ORCs <b>ND</b>	<b>ND</b>
<b>Nov 2016</b>	7.6M in 87 districts at risk - 29 cholera confirmed districts - 58 high risk districts - Estimated duration 3-6 months	Sword and Shield approach for control in 29 affected districts and prevention in 58 non-affected districts; emphasis on DTCs, hygiene, chlorination, integrated community case management for diarrhea and ORCs, supplies and medicines, RDTs and expanding RRTs	Led by national CTF; feedback to subnational CTF, GHO and Emergency Health Rooms (Sana, Aden)	Ibid.	Expansion of use of RDTs to remote areas <b>ND</b> of expansion of culturing capacity or systematic approach for RDTs	60 DTCs to be established (26 operational); location not discussed ICCM and ORCs (community surveillance)	<b>ND</b>
<b>Jul 2017</b>	26M in all 333 districts at risk - 286 cholera confirmed districts (control) - 47 low risk districts (prevention) - Estimating 280,358 cases over 6 months; 70,090 severe cases	Sword and Shield approach focusing on: coordination of health and WASH response, surveillance, case management, referral, IPC, increase capacity of Ministries, community awareness	Establishment of EOC/IMS in Sana, Aden with new EOCs in all governorates; adopt operational posture	Case definitions given RRTs developing	+++ central public health lab, governorate branches in main hospitals for decentralized testing of samples <b>ND</b> of systematic approach for RDTs	5,000 DTC beds and 2,003 ORCs; each district affected receives one CTC (20 beds on average) and at least five ORCs Health partners provide full support to health facility	Reactive and preventative risk assessments recommended.
<b>Feb 2018</b>	9.8M in 100 high risk districts for endemic cholera (active transmission, high density)	Sword and Shield approach focusing on: - Preparedness in high risk districts - Early intervention at onset of outbreak - Outbreak response - Positioning and warehousing of supplies - C4D in unaffected and affected districts; largely through 10,000 community volunteers (CHVs, Imams, etc)	Describes interaction of CTF, clusters, EOC/IMS, implementing partners	6 EOCs established in Aden, Sana'a, Amran, Ibb, Hodaydah and Hajjah to oversee surveillance and response (not coordination); EOC to provide data to WASH teams at local level in realtime; switch from eDEWS to Excel; 307 RRTs established in districts; 248 WASH RRTs in 22 governorates; RRTs enable field investigations and early response	+++ seven labs in San'a, Aden, Hodeidah, Taiz, Sayon, Mukilla and Sa'ada; sample transport systems Systematic RDT plan for every 10 <sup>th</sup> suspected case	4,064 DTC beds in 282 DTCs and 1294 ORCs SAM emphasis	Preventative OCV plan based on risk assessment included. If an outbreak occurs, ready to discuss and expand OCV to new districts.



# ANNEX 4: DTC MONITORING CHECKLIST, NOVEMBER 2017

Monitoring and Evaluation of DTC			
Monitoring and Evaluation of DTC			
Facility Information			
Name	Evaluation information		
Address	Name of evaluators		
Administrative level			
Type (Public, NGO, mix...)			
Supporting NGO			
Facility capacity			
	Person from facility participating in evaluation		
Access to facility / entry point			
The entrance of the facility is clearly identified	Excellent	Average	Poor
Handwashing stations are available at point of entry with chlorine solution 0.05%			
Foot bath or spraying of shoes are available at the point of entry with chlorine solution 0.2%			
A staff is posted at the entry to ensure washing of hands and shoes 24 hours a day			
Organization of the space			
The layout and access to different spaces is organized following the guidelines provided			
Patients are separated according to severity of illness			
All areas are maintained properly ordered, clean and tidy			
Handwashing stations with chlorine solution 0.05% at the entry and exit to the wards			
Screening/admission and observation areas (mild to moderate)			
The time of arrival of patients is clearly noted			
Information is correctly filled			
The age range of patients is clearly noted			
Patients are screened, and their level of severity defined according to protocol			
Severe cases are immediately given IV fluids and transferred to the hospitalisation area			
The condition of patients is evaluated every 30 minutes			
The preparation of ORS is ready, prepared with treated water and available at the location			
Cups for ORS are disinfected and available			
Hospitalisation area			
A staff is stationed 24 hours a day at the entry of the space to ensure hands and shoes are washed			
The patient's file is correctly filled in and the admission time is registered			
The patient record is frequently filled and kept near the patient			


The patient's clothes are sent to laundry services (see below on how they should be washed)		
Approx. 1 cm (half a cup ↔ 100-125 ml) of chlorine solution 2% is put into the buckets for faeces and vomit before placement		
Another half a cup (100-125 ml) of chlorine solution 2% is poured in the buckets that are 2/3 filled with faeces and vomits, covered for 30 minutes and disposed into a pit/latrine.		
The empty buckets and basins are cleaned with chlorine solution 2%		
The condition of the patient is evaluated and registered every 30 minutes		
Each patient has ORS available and is encouraged to drink		
<b>Uniforms of staff, bed linen and laundry</b>		
Staff in charge of disinfection activities use mask, googles, gloves and rubber boots.		
There is a designated area for laundry		
All staff uniforms are kept and cleaned at the center		
All bed linen and gowns are washed at the center		
The clothes that belong to the patient are washed (as indicated above) and given back when they reach the recovery area	Immerse 10 min in chlorine solution 0.05% (drying lines are available near to the laundry area).	
The condition of patients is evaluated every 30 minutes		
The preparation of ORS is ready, prepared with treated water and available at the location		
Cups for ORS are disinfected and available		
<b>Hospitalisation area</b>		
A staff is stationed 24 hours a day at the entry of the space to ensure hands and shoes are washed		
The patient's file is correctly filled in and the admission time is registered		
The patient record is frequently filled and kept near the patient		
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The condition of the patient is evaluated and registered every 30 minutes		
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<b>Uniforms of staff, bed linen and laundry</b>		
Staff in charge of disinfection activities use mask, googles, gloves and rubber boots.		
There is a designated area for laundry		
All staff uniforms are kept and cleaned at the center		
All bed linen and gowns are washed at the center		
The clothes that belong to the patient are washed (as indicated above) and given back when they reach the recovery area	Immerse 10 min in chlorine solution 0.05% (drying lines are available near to the laundry area).	
<b>Kitchen and meals</b>		
If food is brought by carers it should be evaluated and preferably transferred to a new container at the gate (the new container should be washed and kept at the centre).		
Handwashing stations are available with chlorine solution 0.05%		


<b>Dishes</b>			
There is a designated area to wash dishes			
Cups and dishes used for ORS are washed with a chlorine solution 0.05%			
<b>Water</b>			
Water is available at all times and in all critical locations (for cooking and preparation of ORS, handwashing, bathing and cleaning purposes).			
Water for consumption has turbidity less than 5NTU and chlorine residual of 0.5 - 1.0 mg/l and is tested regularly			
The quantity of water stored is enough for at least 3 days (based on 60 litres/patient/day + 15 litres/carer/day)			
<b>Hygiene</b>			
Handwashing stations have drainage into a covered soakpit or buckets. If buckets are used, they are emptied when they are full into a soakpit/latrine.			
Health staff and relatives wash hands after each manipulation of the patient			
The center has 1 private/shower room per 50 patients or caregivers (minimum 2, male/female)			
The center has minimum 2 private/shower room (male/female) for staff in the Neutral area			
There are cleaners employed 24 hours a day in the facility			
<b>Disinfection</b>			
Chlorine solutions 0.2% and 0.05% are prepared daily			
The foot bath is regularly soaked with the appropriate solution			
The floors are cleaned with chlorine solution 0.2% 3 times per day and each time it is necessary			
Beds are disinfected after each use with chlorine solution 0.2% and then dried			
<b>Latrines</b>			
The center has 1 latrine per 20 patients or caregiver in the observation/screening and recovery area (min. 2 latrines, male/female)			
The center has 1 latrine per 50 patients in the hospitalization area (min. 2 latrines, male/female)			
The center has at least 2 latrines (male/female) for staff in the Neutral area			
The center has at least 2 latrines (male/female) for visitors outside of the centre			
Latrines are easy to clean and are cleaned several times a day with chlorine solution 0.2% (this includes the slabs and the walls up to 1m or height of splashes).			
Handwashing stations with chlorine solution 0.05% are provided at all latrines (separate for men and women)			
<b>Waste Management</b>			
The center has a designated area to bury the faeces and vomit of the severe cases (or another safe disposal method such as pit latrine)			
Waste management is ensured in an optimal manner (incinerator/ septic tank)			
Latrines are desludged at a regular basis by specialised and sludge is disposed safely			
The area for the disposal of faeces is in an isolated area			
Handwashing stations with chlorine solution 0.05% are available			
<b>Dead bodies management</b>			
The center has a designated isolated area for the dead bodies			
Handwashing stations with chlorine solution 0.05% are available			
Designated staff are trained to prepare and disinfect dead bodies			

Dead bodies are disinfected with chlorine solution 2% (see Annex 9D for details on management of dead bodies)		
There are enough body bags or cloth to wrap the body available in the center		
<b>Stocks</b>	<b>1 month</b>	<b>15 days</b>
HTH		
Gloves		
ORS		
Ringer Lactate		
Catheter IV		
Chlorine		
Doxycycline		
Erythromycin		
<b>Data management</b>	<b>Excellent</b>	<b>Average</b>
The number of cases received and discharged in the center are correctly registered		
The number of deaths is registered, and the day and hour are noted		
Record of quantity of medicines dispensed for patients		
The data of the center are transmitted to the MoPHP on a daily basis		
<b>Case management</b>		
#REF!		
<b>Staff knowledge/performance</b>		
#REF!		
<b>IEC and community services</b>		
The ill leaving with their families are informed of follow-up and management at home		
A follow-up of the patient at home is organized		
For severe cases, the center has the means to ensure the house of the patient is disinfected		
The center has an ambulance available or other means to transfer the ill		
The center has an updated list of DTCs in the departments publicly available		
The center has a phone number for ambulance services		
The center advice on existing dead body transport services		
<b>Exit area</b>		
The center has a designated recovery area		
The exit point is different and separated from the entry point		
A staff is stationed at the exit point 24 hours a day to make sure hands and shoes are washed		
<b>Incentive Payment</b>		
Is attendance sheet available for staff to sign		
How many staff working per shift		



ANNEX 5: PATIENT CARD MODIFIED TO INCLUDE REFERENCE TO SEVERE ACUTE MALNUTRITION





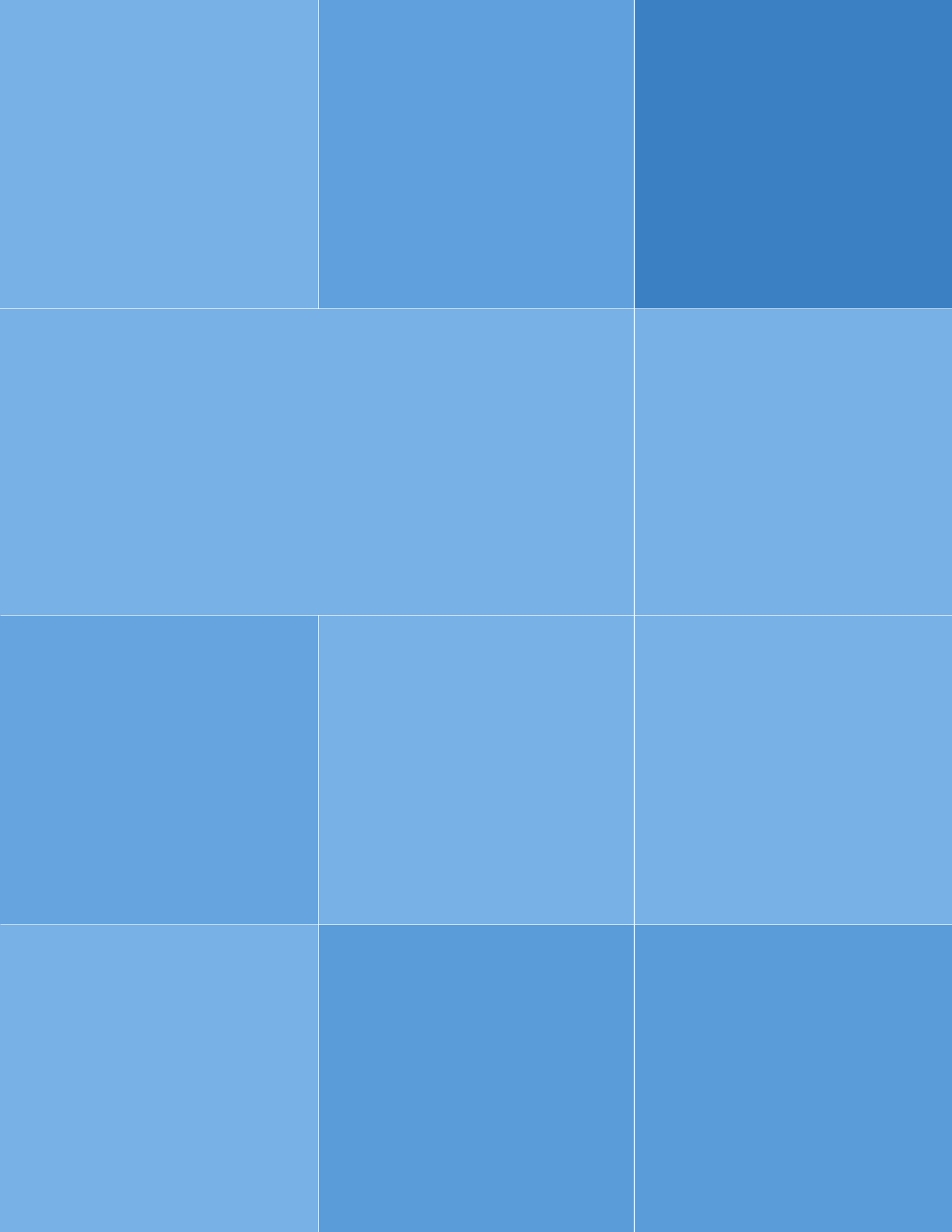
### Monitoring of Cholera/Diarrhea Children - DTC

Name of facility: Weight (kg) at Admission: \_\_\_\_\_

27 Sep 2017 Village/locality: \_\_\_\_\_ Mobile: \_\_\_\_\_

Name of Patient		Sex:	Date of admission:	Number:	Age
<b>History at Admission</b> Pulse: _____ Number of stool/flst 24 hrs.: _____ Type diarrhea: _____ If AWD, started when? _____ Other signs: _____		Conscience: _____ No. of Vomits: _____ MUAC mm: _____ Height/length cm: _____ Oedema Y/N: _____ SAM Y/N: _____ Blood Sugar mg/dl: _____	If child on Plan A - Follow-up (Every 2hr) Time-> _____ Pulse: _____ Diarrhea: _____ Vomits: _____ ORS planned: _____ ORS received: _____ Dehydration status (A/B/C): _____ Breast feeding (Y/N): _____		
<b>Hospitalization</b>					
Date-> _____ Time-> _____ No pulse / weak / strong _____ Pulse per min _____ Diarrhea-stools (times) _____ Vomits (times) _____ Urine (times) _____ Temperature (C) _____ Respiratory rate _____ Dehydration status (A/B/C) _____ Antibiotics type _____ Antibiotics dosage _____ IV fluid TYPE _____ IV fluid Planned (volume) _____ IV fluid Received (volume) _____ LowOsmolORS/ReSoMal _____ Rehydr. Oral/NG _____ ORS planned _____ ORS received (volume) _____ Therapeutic milk TYPE _____ F75orF100planned(volume) _____ F75orF100 received(volume) _____ Breastfeeding Y/N _____ Zinc (dosage) _____ Other diagnosis: _____					
Date of exit: / /    Transfer <input type="checkbox"/> Cured <input type="checkbox"/> Death <input type="checkbox"/> Abandon <input type="checkbox"/>					
Dehydration: No(A) Moderate(B) Severe(C)		cases of death: _____ time of death: _____ Discharge weight (kg): _____	Blood transfusions (volume): _____ SAM Y/N: _____ SAM child referred to OTP/IFC Y/N: _____	Comments: _____	

\*Vital signs should be monitored each 10-15 min if IV fluids given in a child with SAM; otherwise each half an hour for the first 2 hours, then once each hour for 10 hours, then as recommended by the physician





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