

**ORIGINAL ARTICLE**



# A Tool to Monitor Multi-Sectoral Response Activities During Outbreaks of Cholera in Sudan

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**Abstract:**

**Background:** Very little has been reported on assessments of outbreak response activities undertaken in affected areas. There were no indicators to monitor the performance of the implemented multi-sectoral interventions.

**Objective:** To provide rapid and reliable interim assessment of the implemented control measures so that professionals and decision-makers modify and improve their response strategies in management of recurring outbreaks of cholera before, during and after their occurrence.

**Material and Methods:** Guided with the ten pillars supported by the Global Task Force on Cholera Control (GTFCC), two sets of indicators were developed to assess Key Performance Indicators (KPI) of multi-sectoral response activities during the outbreak and resilience of health system in Gadarif during the outbreak. The KPIs were extracted from WHO publications, published reports in peer-reviewed medical journals.

**Results:** A group of experts in Gadarif State were satisfied with the performance of the MOH in implementing six out of ten pillars of cholera control: Leadership, coordination, planning and monitoring; Risk Communication and Community Engagement (RCCE); Water, Sanitation and Hygiene (WASH); laboratory diagnostics and testing; Infection Prevention and Control (IPC) and case management. They gave low scores for activities related to surveillance and outbreak investigation, operation support and logistics, continuity of essential health and social services (or resilience) and vaccination. The scores for the five elements of resilience of health and medical services during the outbreak were quite low.

**Conclusion:** The assessment tool highlighted strengths and weaknesses in the outbreak control activities. The tool could be used for rapid assessments to monitor the performance of different interventions throughout the course of the outbreak, and to strengthen preparedness.

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**Keywords:** Cholera, Case-fatality Ratio, Sudan, Outbreak, Outcome, Determinant, Rapid Assessment Tool, Response.

## 1. INTRODUCTION

Worldwide, there are approximately 4 million cases and 143,000 deaths each year due to cholera [1]. Recurring cholera outbreaks in the Eastern Mediterranean Region (EMR), are primarily due to inadequate access to safe water, sanitation, and hygiene; and indicate weak health systems in the affected countries [2]. In 2016, the World Health Organization (WHO) established the WHO Health Emergencies (WHE) Programme to assist member states in developing capacities for preventing, preparing for, detecting, re-

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sponding to, and recovering from public health emergencies, including cholera outbreaks [3, 4]. Outbreaks of epidemic-prone diseases expose the weaknesses of health systems. The assessments of the outbreak responses are undertaken to identify strengths and weaknesses to inform planning for improved preparedness and response towards future outbreaks [5]. Usually health authorities tend to evaluate the control measures at the end of the outbreak to identify lessons learned [6]. The two key epidemiologic indicators used during a cholera outbreak are the attack rate and the case fatality ratio or rate. These indicators are standard measures of epidemic intensity and impact. They allow for comparisons between different locations and previous outbreaks [7].

In 2017, the Global Task Force on Cholera Control (GTFCC) launched an initiative entitled “Ending Cholera: A Global Roadmap to 2030”, with the objective to reduce cholera deaths by 90% worldwide, and eliminate cholera in at least 20 countries by 2030 through implementation of well-coordinated, timely and effective multidisciplinary responses [7]. The ambitious global roadmap to end cholera by 2030 requires countries of endemicity to use evidence-based solutions to make this goal a reality [1]. The adoption of ten pillars for control of cholera made it difficult to monitor the successes, gaps and challenges that hampered successful implementation of each pillar. There is need to develop a simple tool to quickly assess and monitor the performance of different responses implemented during and after occurrence of an outbreak of cholera that identifies successes and gaps in implementation of each pillar. Despite the recurring cholera outbreaks in Sudan, very little has been reported on assessments of outbreak response activities undertaken in affected areas. The aim of this tool is to help professionals and decision-makers improve their response strategies in management of recurring outbreaks of cholera before, during and after their occurrence.

## 2. MATERIAL AND METHODS

Gadarif State of southeastern Sudan (Population: 2,854,132) is diverse, composed of various ethnic groups, including representatives of different tribes that contribute to a multicultural tapestry. In addition, there are communities from neighboring countries. The State has a history of repeated outbreaks of cholera during the last three decades. On 02 October 2023, The Federal Ministry of Health (FMOH), Sudan, declared emergence of a cholera outbreak in Gadarif State. More than 260 suspected cases of cholera were reported, including 22 laboratory-confirmed cases.

## 3. ASSESSMENT TOOLS

The World Health Organization (WHO) Global Strategic Preparedness, Readiness and Response plan for cholera- April 2023 – April 2024 (SPRRP) identified ten inter-related pillars and alignment with core components of WHO’s work for health emergency preparedness, response, and resilience of health and medical services [7]. The investigators used these pillars to assess the implementation of response activities to cholera outbreaks. The investigators developed two sets of Key Performance Indicators (KPI) to assess all the pillars of response of cholera identified by WHO, the multi-sectoral response activities during the outbreak and resilience of health system in Gadarif during the outbreak. The KPI were extracted from WHO publications and published reports in peer-reviewed medical journals. The interventions include a combination of authentic leadership and coordination, functional surveillance, appropriate case management, improved water, sanitation, and hygiene (WASH), Oral Cholera Vaccines (OCV) and social mobilisation interventions. The tool aims at objectively monitoring progress and impact in cholera responses around the ten pillars of intervention to foster improvement in performance, quality, accountability and reporting. Another similar tool was developed to especially assess the resilience of health system in Gadarif during the outbreak.

## 4. ASSESSMENT OF MULTI-SECTORAL RESPONSE ACTIVITIES DURING THE OUTBREAK

The Delphi technique is a way of obtaining a collective view from individuals about issues where there is no or little definite evidence and where opinion is important. The process enables cohesion among indi-

viduals or who are anonymous with diverse views, and allows to reappraise their views in the light of the responses of the group as a whole [8]. The Delphi technique facilitates building consensus on the most important challenges and solutions for implementation [9]. With assistance of a group of experts, the investigators developed a scoring for each indicator within each pillar where the weight for each score commensurate with its relative importance. The total score for all indicators for a single pillar was 100. Using an excel sheet, the indicators were assigned random numbers from 100,000 to 900,000. Then the indicators were sorted to have a new list with random lines, printed, tested, and translated into Arabic. Imputed-generated random numbers were assigned for indicators and the checklist was sorted from the smallest to the largest random number to shuffle the list so that the respondents would not easily guess the purpose of the question. Forty experts were requested to give their score using one decimal point to their best educated guess. The experts included members of the Cholera Task Committee, representatives of UNICEF, International Non-Governmental Organizations, heads of the different relevant directorates in the SMOH, and directors of health affairs in the localities. The investigators made different efforts to assure the participant experts on the anonymity and confidentiality of the response. Data were entered in an Excel sheet and the mean of the scores for each observation was calculated. Similarly, another tool was developed by the Outbreak Investigation Team to assess the resilience of health system in Gadarif during the outbreak. Five Key Performance Indicators (KPIs) were used to assess the resilience of health and medical services in Gadarif State. The results of these KPIs indicated significant disruptions to healthcare services during the cholera outbreak.

The tools were completed by experts included members of the Cholera Task Committee (CTF), representatives of UNICEF, International Non-Governmental Organizations, and heads of the different relevant directorates in the SMOH, directors of health affairs in the localities. The participants included the district director of health service and the district disease control and surveillance officers. We also involved the health staff involved in the management of cholera cases during the outbreak. The investigators made different efforts to assure the participant experts on the anonymity and confidentiality of their responses. The Outbreak Investigation Team (OIT) obtained data on water quality and residual chlorine at household level. Excel software (version 7.2) was used for data entry and calculation of the mean and standard deviation and drawing the radar or spider chart.

Similarly, another tool was developed by the Outbreak Investigation Team to assess the resilience of health system in Gadarif during the outbreak. Five KPIs were used to assess the resilience of health and medical services in Gadarif State. The results of these KPIs indicated significant disruptions to healthcare services during the cholera outbreak.

## **5. RESULTS**

The group of experts in Gadarif State were satisfied with the performance of the MOH in implementing six out of ten pillars of cholera control: Leadership, coordination, planning and monitoring; risk communication and community engagement (RCCE); water, sanitation and hygiene (WASH); laboratory diagnostics and testing; infection prevention and control (IPC) and case management. They gave low scores for activities related to surveillance and outbreak investigation, operation support and logistics, continuity of essential health and social services (or resilience) and vaccination (Table 1, Figure 1). The scores for the five elements of resilience of health and medical services during the outbreak were quite low (Table 1, Figure 2).

The following good practices were observed during the control of the outbreak. They include but not necessarily limited to:

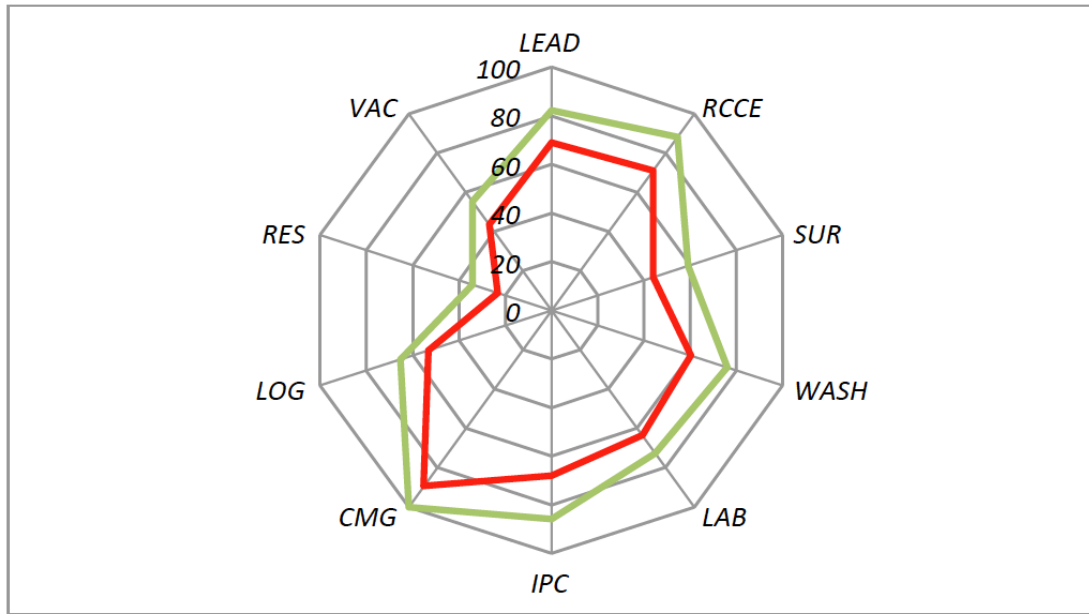
1. Declaration of the outbreak: The Federal Minister of Health demonstrated transparency as he officially declared the occurrence of the outbreak soon after the diagnosis of cholera was laboratory-confirmed.
2. The Director General, Health Affairs, Gadarif firmly objected closure of health facilities or refusal of the HCWs to work should a case of cholera be admitted to their respective health facilities.

3. Involvement of the Gadarif Municipality and many UN International Organizations and International Non-governmental Organizations (INGO) in the response activities.
4. Prompt deployment of the Rapid Response Teams (RRTs) during the outbreak for completion of case investigation forms, active case identification, water quality monitoring and hygiene promotion to reduce local transmission from person-to-person or transitory environmental contamination.
5. There were intensified joint efforts whereby SMOH worked closely with Gadarif Municipality and WHO to chlorinate water and to monitor the free residual chlorine at household level.
6. Hospitals and other health facilities implemented a triage system to rapidly identify suspected cases of cholera who require urgent life-saving interventions.
7. The Cholera Treatment Centers were operated by well-trained and dedicated HCWS.
8. The SMOH made effort to reach religious and community leaders to promote engagement of communities in response activities.
9. During the OCV campaign, the SMOH noted that the proportion of adults was not as expected due their absence from homes. A timely corrective measure was made and mobile vaccination team were taken to the markets.

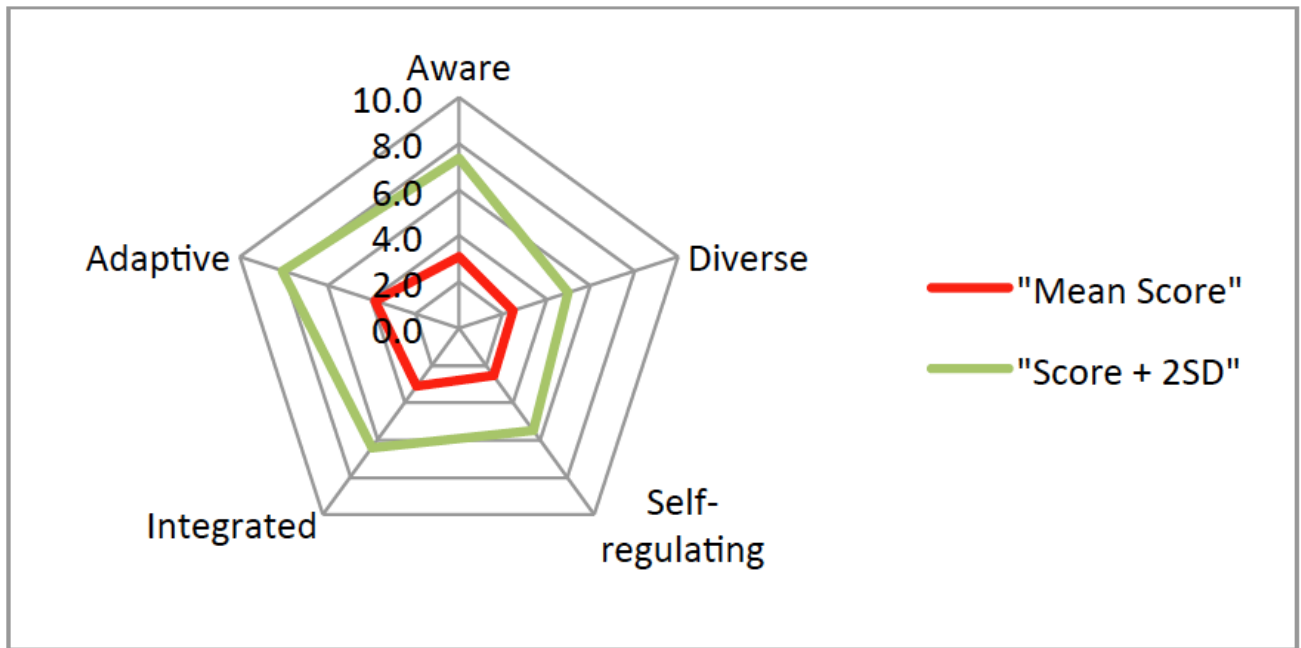
**Table 1. Assessment of the performance of the pillars of multi-sectoral response activities and the resilience of health and medical services during an outbreak of Cholera in Gadarif, November 2023**

Pillar	Mean	SD	Median	Mode	Range	IQR
1: Leadership, coordination, planning and monitoring	69.0	6.8	70.0	61.0	57.0 - 57.0	64.0 - 74.3
2: Risk communication and community engagement (RCCE)	71.1	8.8	72.5	79.0	51.0 - 51.0	66.5 - 78.0
3: Surveillance and outbreak investigation	43.9	7.8	44.8	45.0	25.0 - 25.0	42.9 - 47.3
4: Water, sanitation and hygiene (WASH)	60.3	8.1	61.5	58.0	42.0 - 42.0	55.5 - 66.0
5: Laboratory diagnostics and testing	63.5	4.7	64.5	68.0	51.0 - 51.0	60.9 - 66.9
6: Infection prevention and control (IPC)	68.0	9.2	67.8	67.5	43.0 - 43.0	64.4 - 73.6
7: Case management	89.3	8.5	92.0	97.0	68.0 - 68.0	84.4 - 96.6
8: Operation support and logistics (OSL)	53.2	6.1	54.5	50.0	36.0 - 36.0	49.8 - 57.3
9: Continuity of essential health and social services	23.3	5.6	22.5	19.0	14.0 - 14.0	19.0 - 26.5
10: Vaccination	43.5	6.1	45.0	47.0	26.0 - 26.0	40.8 - 47.3
Resilience of Health and Medical Services	Mean	SD	Median	Mode	Range	IQR
1: Aware	3.1	2.2	2.8	3.4	1.0 - 1.0	1.5 - 1.8
2: Diverse	2.5	1.3	2.4	2.4	0.9 - 0.9	1.6 - 2.6
3: Self-regulating	2.5	1.5	2.8	0.7	0.7 - 0.7	1.1 - 3.8
4: Integrated	3.1	1.7	2.9	NC	0.8 - 0.8	2.2 - 4.1
5: Adaptive	3.8	2.2	3.3	NC	1.2 - 1.2	2.1 - 3.8

Abbreviation: IQR: Inter-Quartile rang



**Figure 1:** A radar (spider) graph summarizing the Key Performance Indicators (KPI) of the responses to the outbreak of cholera in Gadarif State, Sudan (August-December, 2023). The red line (boundary) is the actual mean score of the attribute (out of 10 points) as granted by the experts. The green line is the mean + 1.96 standard deviations from the mean. Key for the abbreviations used in the radar chart: LEAD = Leadership, coordination, planning and monitoring; RCCE = Risk communication and community engagement; SUR = Surveillance and outbreak investigation; WASH = Water, sanitation and hygiene; LAB = Laboratory diagnostics and testing; IPC = Infection prevention and control; CMG = Case management; OSL = Operation support and logistics; RES = Continuity of essential health and social services (Resilience) and VAC = Vaccination.



**Figure 2:** A radar (spider) graph summarizing the five different elements used to assess resilience of health and medical services in Gadarif State, Sudan during the outbreak of cholera August- December 2023. The red line (boundary) is the actual mean score of the attribute (out of 10 points) as granted by the experts. The green line is the mean + 1.96 standard deviations from the mean.

**Table 2. Summary of the findings and observations that adversely affected the resilience of the health system in Gadarif during the outbreak of cholera in 2023.**

Resilience Criterion	Findings/Observations	Degree of Disruption **
<p><b>Aware<sup>1</sup></b></p>	<ul style="list-style-type: none"> <li>• Disease surveillance in Gadarif State could not be strengthened during the cholera outbreak.</li> <li>• Resources were already exhausted by the outbreak of dengue that preceded the outbreak of cholera</li> <li>• The State Government delayed the release of funds for health activities</li> <li>• The SMOH did not make use of the residents of Field Epidemiology Training Program (FETP) and academicians at University of Gadarif</li> <li>• Inadequate transparency</li> <li>• Disease surveillance data and case-investigation forms were not analyzed adequately.</li> <li>• HCWs did not receive timely and satisfactory incentives and remuneration</li> <li>• The information generated by the disease surveillance was hardly used for decision</li> <li>• The SMOH did not share its strategic plan for health with partners</li> <li>• Limited linkage between surveillance and public health lab</li> <li>• Limited laboratory capacity to confirm and characterize the causative agent</li> <li>• Limited capacity to timely compile, analyze and interpret for informed decision-making to tailor response to needs</li> </ul>	<p>Major</p>
<p><b>Diverse<sup>2</sup></b></p>	<ul style="list-style-type: none"> <li>• SMOH did not timely implement the recommendations of Cholera Task Force and the Technical Committees based on data on health and health-related matters from national and International Non-Governmental Organizations, especially in issues related to chlorination of water</li> <li>• The Staff in the surveillance department are not well-equipped with computers and telecommunication tools to enable them to work efficiently.</li> <li>• It took too long to get stool specimens to the RPHL-G.</li> <li>• The State Public Health Laboratory did not have the capacity to confirm and characterize causative agents during the outbreak.</li> <li>• There was no budget for recruiting consultants to conduct in-depth studies</li> </ul>	<p>Major</p>
<p><b>Self-regulating<sup>3</sup></b></p>	<ul style="list-style-type: none"> <li>• The SMOH did not have the technical ability financial resources, to deal with two or more concurrent outbreaks</li> <li>• The SMOH did not have the ability to serve and monitor the health services provided to IDPs, refugees</li> <li>• There are enough stockpiles of chlorine and medicines in Gadarif for unforeseen emergencies</li> <li>• The staff of the State Ministry of Health has not received suitable training on disaster management</li> <li>• There are not enough number of hospital beds in the CTC</li> <li>• The SMOH faced difficulties in swiftly reorganize itself to cope with public health emergencies</li> </ul>	<p>Major</p>
<p><b>Integrated<sup>4</sup></b></p>	<ul style="list-style-type: none"> <li>• The SMOH has not identified lessons learned from previous public health emergencies, including outbreaks</li> <li>• High turnover of the trained staff has affected the quality of work in the SMOH</li> <li>• The SMOH recognized the role of NGOs and partners but could not fully make use of their potential capacities for logistic and operational costs</li> <li>• The composition of the Cholera Taskforce was mostly junior HCWs with limited technical capacities</li> <li>• The health facilities suffer from water shortage, and adequate sanitary facilities</li> <li>• Different service providers and program partners were involved</li> <li>• The level of information sharing is largely limited to AWD taskforce members. No discussions on non-communicable diseases</li> </ul>	<p>Major</p>

(Table 2) Contd....

Resilience Criterion	Findings/Observations	Degree of Disruption **
Adaptive <sup>5</sup>	<ul style="list-style-type: none"> <li>The SMOH did not conduct one or more need assessments of health and or medical services provided during the outbreak.</li> <li>The SMOH did not consider or keep track of commentaries on the social media, including circulating rumors related to health and medical services</li> <li>The SMOH could not recruit adequate number of HCWs to assist in provision of health and medical services</li> <li>The SMOH did not redistribute the HCws within the State according to the workload.</li> <li>The SMOH could not successfully adapt zero reporting and active case finding during the outbreak</li> <li>The SMOH could not adequately implement EWARs and community event-based surveillance system</li> <li>The SMOH established only two CTCs in Gadarif City</li> <li>The SMOH did not fully engage hospital clinicians in AWD case management (perceived not as part of routine duty by some clinicians)</li> </ul>	Major

Note: \*\*\* Degree of Disruption and or Level of adjustment are classified as Major, Moderate, Minimum

<sup>1</sup>**Aware:** Aware of potential health threats and risks to the population from biological and non-biological sources. Awareness needs strategic health information systems and epidemiological surveillance networks that can report on both the status of the system and impending health threats in real time, allowing predictive modelling.

<sup>2</sup>**Diverse:** Health systems that have the capacity to address a broad range of health challenges rather than a targeted few are more stable and capable of detecting disturbances when they arise.

<sup>3</sup>**Self-regulating,** is the ability to contain and isolate health threats while delivering core health services and avoiding propagating instability throughout the system.

<sup>4</sup>**Integrated:** resilient health systems bring together diverse actors, ideas, and groups to formulate solutions and initiate action. Sharing of information, clear communication, and coordination of multiple actors are hallmarks of integration and are best achieved by having a designated focal point in the health system.

<sup>5</sup>**Adaptability:** is the ability to transform in ways that improve function in the face of highly adverse conditions.

Factors affecting implementation were identified including delayed supplies of materials, insufficient quantities of materials and limited or lack of coordination with local government or other agencies. Based on this review, the following recommendations are made to improve cholera prevention and control efforts: explore improved models for epidemic preparedness, including rapid mobilization of supplies and deployment of trained staff; invest in and strengthen partnerships with national and local government and other agencies; and to standardise reporting templates that allow for rigorous and structured evaluations within and across countries to provide consistent and accessible data. Table 2 highlights the factors that compromised the resilience of health and medical services during the outbreak of cholera.

## 6. DISCUSSION

The tool provided an overall assessment of the components of the responses to a cholera outbreak. The tool revealed strengths and weaknesses in the response activities to the outbreak of cholera in Gadarif in 2023 and identified pillars in the response strategy for cholera with inadequate performance. This tool could easily be used for repeated assessments to monitor change in the KPIs and could be used to ensure good preparation for similar outbreaks that could occur in the future. The use of KPIs is essential to monitor response interventions as what is not monitored will not be implemented. The tool made it simple to monitor the performance of a complex array of 10 multi-disciplinary pillars for cholera control, guide allocation of resources, and objectively measure achievement against target. Government and stakeholders; especially donors, require regular progress reports on the instituted response interventions and their impact using KPIs to make informed financial and operational decisions. With some little modifications, the tool could be used for assessment of preparedness and control measures for other epidemic-prone diseases.

The WHO strategy for cholera defined an approach that involves multi-sectoral interventions [2]. The tool pointed to the need to strengthen the capacities of current surveillance system. The elements of the tool suggest that decision-makers would need to consider using different modalities of active surveillance, to ensure early detection, confirmation, and timely response to contain outbreaks. Adequate transparency,

whereby surveillance data is shared with entrusted partners, would enhance coordination mechanism for technical support, and implementation of multi-sectoral approaches to prevent cholera recurrence; including effective advocacy and resource mobilization. The tools reflected some dissatisfaction related to the mass vaccination operation. Unsurprisingly, the tool revealed the fragility of the health services in Gadarif and the low level of resilience of the health and medical services during the outbreak. This is probably due to the unexpected influx of large numbers of Internally Displaced Populations (IDPs) from Khartoum due to the war. The tool validated the complexity of the water system in Gadarif and difficulties in chlorinated water which presented a perplexing problem and posed a continuing high risk for occurrence of repeated outbreaks of cholera.

There is dire need to review and develop better short- and long-term implementable solutions and interventions. With some effort, the Risk Communications and Community Engagement (RCCE) and the Infection Prevention and Control (IPC) could have been better. A post-outbreak workshop is necessary to identify lessons learned for the outbreak and revision of the preparedness plans in the future.

The Delphi technique is a way of obtaining a collective view from individuals about issues where there is no or little definite evidence and where opinion is important. The process can engender group ownership and enable cohesion among individuals with diverse views. It is an iterative questionnaire exercise with controlled feedback to a group of panelists who are anonymous. The design avoids the often counter-productive group dynamics that can occur where individuals are swayed or intimidated by others but allows panelists to reappraise their views in the light of the responses of the group as a whole [10].

## **CONCLUSION**

This technique is useful where the opinions and judgments of experts and practitioners are needed but time, distance, and other factors make it unlikely or impossible for the panel to work together in the same physical location. The findings of the tool could be used by global health organizations to efficiently and optimally direct resources to respond to these key challenges and solutions. The tool presents how to identify strengths and weaknesses of implementing the pillars for cholera control through independent judgments of a panel of experts in a short period of time. The tool is a procedure that is a rapid and efficient way to cream the tops of the heads of a group of knowledgeable people. The tool can be used to gain a consensus where the opinions and judgments of experts and practitioners are necessary; especially, where precise information is unavailable.

## **AUTHORS' CONTRIBUTIONS**

The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

## **ETHICAL APPROVAL OF THE MANUSCRIPTS:**

Not required

## **CONSENT FOR PUBLICATION**

Not applicable.

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## **CONFLICT OF INTEREST**

The author confirms that this article's content has no conflict of interest.



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