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Cholera Prevention and Control Strategies; A Global Overview

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

The observed devastating effects of cholera disease, usually instil fear in the population whenever a cholera outbreak is reported in a particular region. Cholera outbreaks have become key indicators of social development and this is a course for concern, considering the stigmatization that accompanies it. The pathogenic *V. cholerae* O1/O139 (the watery diarrheal causing agent), is shed in feces, survive as free-living bacteria in water and enters a new host system through the fecoral route. There is therefor, every reason to conclude that, water and food (especially raw or undercooked shellfish), that is contaminated with feces, is the most implicated cause of outbreaks and epidemics in the endemic areas of the world. Cholera mortality rate can rise to about 50% if severe cases are left untreated, but rapid fluid replacement therapy and supportive treatment can reduce the mortality to around 1%. Prompt intervention strategies are therefore necessary if cholera deaths must be prevented and controlled. These strategies may include; getting access to good potable and clean Water, Sanitation and Hygiene (WASH) facilities, good surveillance/community education systems, Oral Cholera Vaccine (OCV), Oral Rehydration Therapy (ORS), and prompt Antibiotic treatment. However, it has been noted that most of the regions that are prone to this flesh eating diarrheal disease, are usually, low resource communities with little or no available road networks and infrastructural facilities. These major challenges render most of these cholera prone areas of the world in accessible. To assist these areas (for example the Nigerian population), in the cholera prevention and preparedness, free-of-cost cholera

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Vaccines have been sent from the stockpile to the affected areas. Thanks to the concerted efforts made by Gavi, WHO, and partners, who with the NCDC and Borno State Ministry of Health, have made the vaccine available (to Nigeria) and other hot spots. Moreover, the basic requirements for effective surveillance systems, (effective targeted prevention and control) and early warning units, (detection of the index cases, initiation of outbreak control measures through an integrated approach, identification of high risk areas/vulnerable populations and immediate dissemination of information with stakeholders for timely action), have now put been established in most vulnerable location/cholera hot spots in the world. Better still, the Solidarités International (SIs) which was established in Nigeria since 2016, has intervened in cholera outbreaks especially that which occurred in the Borno state in 2017. They make available to susceptible areas, multi-sectorial, life-saving humanitarian aid, especially to the internally displaced and host communities, who suffer from disease outbreaks. Combining the efforts to improve on water quality, sanitation, hygiene (WASH) and OCVs (targeting the highest risk groups first), would help overcome resource/logistical limitations and enable higher coverage. In this review, we seek to look at the prevention and control strategies put in place by the Government and other bodies, to reduce cholera burden in Nigeria and other cholera hotspots, and the level of effectiveness towards achieving their goals.

Keywords: Cholera; prevention; control; strategies; global overview.

1. INTRODUCTION

Cholera remains a public health threat especially in the less developed countries (Sub-Saharan Africa inclusive) [1], where there are limited resources that can help facilitate diagnosis, prevention and control Islam MT et al. [2] Since the onset of 2019, a bulk of the Eastern and Southern Africa region (ESAR) have been facing cholera rampage from an outbreak that affected about 9,494 people and left 34 dead with a mean case Fatality Rate of 0.4%, from Angola, Burundi, Kenya, Malawi, Mozambique, Tanzania, Somalia, Uganda, Zambia and Zimbabwe. Out of these 10 affected countries of the region, 6,382 (67.2%) of the total number of cases were recorded from Mozambique, while 1, 7359 (18.3%), were reported from Kenya. Furthermore, amongst the four areas (Mozambique, Somalia, Kenya and Tanzania) with current ongoing cholera active transmission, Tanzania has been the worst affected with a record of the highest Case Fatality Rates (CFR) (1.4%) in 2019 [3].

Cholera still remains a worrisome burden in Nigeria even when the annual economic growth seems to have be strengthened. It was observed that from the total cholera cases reported in West Africa between 2012 and 2017, 21.2%, came from Nigeria; while a case fatality rate of approximately 3% was recorded between the period of 2010 and 2017. More so, from the NCDC, reports of 2018, about 90% of the 44,000 suspected cholera cases and 836 deaths, reported in Nigeria in 2018 (Case Fatality Ratio of 1.95%), were from Northern Nigerian states [4]. Furthermore reports of ongoing Cholera epidemics have still been coming from Nigeria (especially form Adamawa & Borno state) even at the beginning of 2019.

Tarh JE, [1] The disease is caused by a Toxigenic strain of a comma-shaped, gram-negative, facultative anaerobe (*V. cholera*), which measures about 1.4–2.6 µm x 0.5-0.8 µm in diameter [5,6]. It is contracted by people who eat food or drink water that has been contaminated by the faecal material, containing *V. cholera* from infected individuals. Cholera has been implicated in explosive outbreaks, pandemics and dehumanizing symptoms. Epidemiologically, it has been estimated to cause approximately 4million infections with a total fatality of 21,000-143,000 worldwide, each year [7]. The major worrying question here is that; If this diarrheal disease called cholera, is both *"both treatable and preventable"*, as stated by the WHO [8], why is it still claiming plenty lives in so many regions of the world? [9]. It has been observed that most of the current major cholera foci of the world, still face some pertinent challenges, which if properly tackled, would reduce, if not stop the incidences of cholera outbreaks. Some of these great challenges include; insufficient cholera preparedness, surveillance, planning data collection and processing strategies, Lack of decentralized and target cholera-specific water, sanitation, hygiene and Case management strategies, Lack of harmonized epidemic and humanitarian coordination systems as well readily available

materials for protecting water systems and health facilities [10].

Since most regions in the world, Africa inclusive and Nigeria in particular belong to the group of major current cholera foci, It became imperative that the Global Roadmap (Global Task Force on Cholera Control (GTFCC *Ending Cholera*]) to reduce the number of cholera deaths by at least 90%, in more than 50% of the cholera-affected countries by 2030, be launched and this was done [1].

In a report given by Monica Ramos, a UNICEF Consultant, during the Sixth Annual Meeting of the Global Task Force on Cholera Control on the 3 - 4 June, 2019, it was stated that "there is a consensus that OCV campaigns should be used to reinforce WASH in the same targeted areas" [11]. This indicates that the total eradication of cholera from the world is possible, if the key pointers already observed can be followed in conjunction with the objectives of the Global Roadmap of *Ending Cholera* by 2030. This therefore means that, if the major preventative and control strategies in clinical settings (clinical and administrative policies towards cholera prevention and control, rapid case identification, compliance with Standard Precautions, adoption of Transmission Based Precautions for patient isolation, contact tracing and treatment, effective case referral system, cholera education/enlightenment of health workers and the community), are rightly put in place and followed [12,13]. Moreover, the provision of easy access to clean drinking water, adequate sanitation and hygiene conditions [14], as well as access to safe, effective, easy-to-administer, heat-stable, and cheap killed whole cell oral cholera vaccines (OCVs), can also provide more tools to curb this cholera disease [15]. Clemens et al. [16], asserted that in addition to the above mentioned cholera reduction strategies, oral and intravenous rehydration therapy, can decrease the percentage of deaths due to cholera from greater than 50% to below 1%. This assertion was buttressed by a statement made by the WHO policy and recommendations 2018, that "ORS can successfully treat 80% of cholera cases", while the right antibiotic therapy, can decrease the period of watery stooling. According to the resolutions from the 71st World Health Assembly of 2018, the cholera affected regions, in conjunction with the Director General were obliged to implement the cholera prevention and control strategies as proposed in the global roadmap objectives. Still in the same vein, the WHO was also saddled with the responsibility of expanding and increasing its ability to aid the affected regions to combat the disease, strengthen surveillance/reporting of cholera, and reinforce its leadership/coordination of global prevention and control efforts [17].

It was on this premise that the World Health Organization (WHO) however, in its "Cholera Prevention and Control Report in Geneva, declared that a 60 per cent reduction in the number of cholera cases was recorded in 2018. This report was as a result of the fact that major cholera hotspots like South Sudan (which never recorded any cholera cases in 2018 and 2019), Haiti, Somalia, the Democratic Republic of Congo, Nigeria, Yemen, etc., have implemented fully, the OCV campaign and other cholera prevention strategies [11]. The decreasing trend of cases culminates with the reduced level of transmission of the disease even in areas where outbreaks still continued into 2019. This, definitely is a fall back of the increasing awareness and concern shown by many regions of the world, towards the implementation of different cholera control strategies (including water, sanitation and hygiene (WASH), as well as mass cholera vaccination campaigns etc); in the global efforts to reduce and prevent cholera outbreaks [14].This study seeks to review these global strategies that have been put in place to reduce the cholera burden in the world, with special attention to Nigeria.

2. CHOLERA PREVENTION STRATEGIES AS PUT IN PLACE BY DIFFERENT BODIES IN SOME REGIONS OF THE WORLD

2.1 The Context of Intervention as A Prevention Strategy

According to reports from https://population.un.org/wpp/DataQuery/UN [18], a bulk of the over 200 million inhabitants of Nigeria, live in the towns and cities projection. Natural disasters, like flood, earth quakes, poverty, wars, insurgency, and risky practices such as funeral rituals, patient care, home visits, informal trade, migrant fishermen, nomadic groups, arrival of new IDPs/returnees, inter-border markets around the shores of Lake Chad etc, usually lead to the displacement of people from their homes [19]. This now poses a critical problem because, the entire nation is faced with the challenge of lack of access to portable water

and sanitation facilities. Similarly, it has also been noted that about 15%-25% of these people have no good toilet facilities, and defecation is done anywhere especially in the rural areas. In the BAY states (north-eastern states of Borno, Adamawa and Yobe), for example, where conflicts have left about 7.1 million individuals scattered all over the territory in search for solace, it has been observed that approximately 80% of these population leave in uncomfortable places that lack good water and sanitation facilities and are therefore, forced to share the limited available resources. In Borno State, UNICEF, reported that, about 57% of the 168 referenced sites, did not meet up with the 15L/people/day SPHERE emergency standards for water and 58% did not also meet sanitation standards of 50 persons/toilet facility, as of February 2019. In some crowded areas like refugee camps, sometimes, the water coverage can be as low as 5 liters/day/person. This is because, a single water facility is expected to be accessed by as many as above 500 persons, who may have to spend about 2 hours on the cue to wait for their turn. This makes the sanitary conditions, even worse (>150 people/toilet facility).

Another certainly more serious problem is the global climate crisis. This has brought about severe effects such as rising sea levels, temperatures, and extreme weather conditions in small Islands of less developed states [20]. These congested conditions favor the outbreak and spread of waterborne diseases such as cholera.

The most effective and appropriate ways of tackling cholera with the aim of it being eradicated, will only revolve around its prevention, case management provision of adequate and good potable water, sanitation (WASH promotion), surveillance activities including health education, and control using Oral Cholera Vaccine (OCV) and antibiotic drugs [21,22,23,24].

2.2 Surveillance as a Prevention Strategy

The prevention and control of cholera basically requires effective surveillance systems. That is, the foundation of an effective targeted prevention and control which is an early warning unit, that expedites the detection of the index case and initiates outbreak control measures (through an integrated approach), promotes the identification of high risk areas/vulnerable populations and allows immediate dissemination of information with stakeholders for timely action [22,23].

3. THE PURPOSE OF SURVEILLANCE SYSTEMS AS EXAMPLIFIED BY THE ZANZIBAR COMPREHENSIVE CHOLERA ELIMINATION PLAN (ZACCEP) 2018-2027 25 [25]

The Surveillance System, is there to strengthen epidemiological and laboratory-based and primary signal systems. Purposefully, this is to enable early identification and prompt reactions to every health threats (such as cholera outbreaks). It operates as an intelligence system (primarily focusing Ministry of Health staff at all levels), creating awareness of Integrated Disease Surveillance & Response (IDSR), International Health regulations (IHR) and system improvement. This awareness drive includes; alert and rapid response system, and improvement of the detection and follow-up of cholera cases.

In their activities, Yearly capacity building mediations are done to health/community workers and volunteers:

- To enable appropriate referral/care of suspected cases.
- Review, translate, print and disseminate IDSR guidelines and other IDSR tools (including, reporting books, case definitions and one pagers)
- Review and develop IDSR training curriculum, supervision and mentoring
- Conduct training for ~20 surveillance officers on IDSR to be responsible for supervising and mentoring other facilities, including specimen collection, handling and transport
- Conduct on-job training, supervision, and mentoring of health workers, laboratory staff and port health staff on IDSR including specimen collection, handling and transport
- Conduct regular (one annual) port health/cross border surveillance meetings
- Conduct annual refresher training for national laboratory staff on culture and sensitivity testing for cholera
- Build capacity of the laboratories in 4 regional level hospitals for culture and sensitivity testing buying incubators, water bath, autoclaves, petri dishes, refrigerators and other supplies

- Construct/renovate lab premises for microbiology services at three (identified) hospitals
- Train 3 microbiologists (2 years' master s course)
- Develop protocols and train staff at primary health care facilities on use of cholera RDTs
- Procure and distribute 100 cholera RDTs to district facilities for use during confirmed outbreaks; replace every 2 years
- Review quality assurance (QA) standard operating procedures (SOP) with National Health Lab and Quality Assurance Training Centre
- Develop SOP for supporting whole genome sequencing for monitoring circulating strains of cholera
- They set up treatment guidelines on cholera.
- Procure and distribute cholera diagnostic laboratory supply to identified facilities
- Introduce electronic IDSR system e.g. mobile, online application, tablet, etc.
- Train facilities health staff on IDSR
- Develop community based surveillance guidelines
- Orient community health structures on community based surveillance guidelines
- Conduct epidemiological study on risk factors, transmission pathway and trends of cholera outbreak
- The set isolation center/corners in identified, selected health facilities during outbreaks.
- They make available good quality/quantity drugs in all health facilities. They monitor and evaluate centers during outbreaks to be sure that case management follows guidelines.

All these are targeted towards keeping the clinical case-fatality rate of suspected cholera below 1% in all outbreaks. This they do by making sure that: At least 90% of suspected cholera deaths are investigated and the contributing factors leading to the death identified.

A minimum of 90% of Cholera Treatment Center (CTC) staff are able to demonstrate proper infection prevention practices.

And finally, that not less than 90% of CTC staff will correctly indicate signs and symptoms of severe dehydration and proper management of dehydration [25].

4. AN EFFECTIVE SURVEILLANCE SYSTEM

For a surveillance system to be efficacious, it must be able to routinely collect, analyze or transport stool specimens for laboratory confirmation of an outbreak and interpret data at the facility, district and national levels for early detection of an outbreaks. It must also, during an ongoing outbreak, be able to investigate effectively, an active case to enable prompt responses on treatment, identify emergency response team contacts and immediately carry out the recording and reporting of cases and deaths) [26].

Passive surveillance sometimes is carried out even when there is no outbreak, most especially to enable the community to get prepared by making useful arrangements that can be immediately applied (prevention and response), in case there is an outburst of a cholera outbreak . It must be noted here that the training of health workers on cholera management is important, for proper detection and reporting of suspected cholera cases. This is because the clinical suspicion of a case of cholera by the health workers at the health facilities, rumours from the community, including Village Health Team members (VHT), local authorities, religious leaders reports, private clinics, drug shops, traditional healers media reports of clustered diarrhea related illness or deaths, information from a hot line or the District health information System Version 2 (DHIS-2) alert system, can easily be investigated and confirmed if there is actually the outbreak or not) [26].

In the Community level, a cholera case is defined as any person passing frequent watery stool in an environment where an outbreak has been declared. A cholera case is suspected when a person of about 5 years of age or more, shows signs of dehydration or dies from severe watery diarrhea. However, for a case of cholera to be confirmed, it has to be that, someone of about 2 years old or more, that lives in an area with cholera epidemic, presents with acute watery diarrhea in which *V. cholerae* serogroup O1 or O139 has been isolated from the stool. The surveillance system then comes in to investigate the confirmed case, trace and established the mode of transmission (water or food) and institute appropriate control measures) [26].

Once there is an established proof that there is a single case in an area, an alert threshold for

cholera is immediately reported to a higher level of management, who then handles and treats the case according to these guidelines: Encourage infection control at all levels, carry out case-based investigation to identify similar cases and collect stool samples from suspected cases prior to the commencement of chemotherapy. Immediately there is proof of one laboratory case of cholera confirmation, a cholera epidemic/outbreak is declared. The following strategies immediately come in to place; a Cholera Treatment Centre (CTC) is established in that area, while the district cholera task force, with aid from the national level and other stakeholders, then coordinate prevention and control interventions) [26].

Community participation is often very much necessary, in areas with active cholera reports. This involves the engagement of the members of the community, leaders and VHTs in the identification and referral of suspected cholera cases for timely for confirmation. They carry out contact tracing to identify and follow up people who interacted closely with cholera cases within seven days of exposure, or those who visited / stayed in the household of cholera cases. They also detect any case for onward referral to the health facility, give home treatment to mild cases, selective chemoprophylaxis to those who had contacts with cholera cases but who have not yet manifested the signs and symptoms, encourage household treatment of drinking water with chlorine or by boiling, encourage WASH measures, food safety, health education on prevention and control of cholera, record status of each exposed person, and submit the Situational reports **(Strep)** to the Epidemiological Surveillance Unit (ESD), Control of Diarrheal diseases Section (CDD) and Emergency Operational Centre (EOC) [26].

5. CASE MANAGEMENT

The surveillance system also assists in the aspect of improving the quality of patient care by making sure that the patients get quick and efficacious therapy to avoid morbidity and death at the community and health-facility levels. This is usually made available by training the health workers in the diagnosis, management, infection prevention and control measures. Also, provision are made for drug stands, supplies and other necessary materials that may be of great assistance to prevent the spread, treat and control cholera [25].

6. ASSESSING THE OUTBREAK DETECTION

When a cholera outbreak is detected from an area, the appropriate health authorities must be notified of the signal cases, either via the surveillance system, media release, radio announcements, informal sources, and any other available means. This primary signal must be well noted, for example; from the onset, what was the alarm that told the population about the possible occurrence of an outbreak? Was there an immediate occurrence of cholera? Were there automatic rise in the number of cases or abnormal number of deaths? Was it just alone case or many cases at the same period?

This assessment must take into consideration the following: Whether the case incidence was greater compared with the same period of time in previous years? The length of time the information took to arrive at the decision making level from the point of outbreak (which must not be greater the seven days). Whether the daily situation report was actually put together and tendered by the district and what primary response was made by the health facility or district. Were telephone calls made to the affected places to investigate these claims or was a rapid-response team sent immediately to the area? [26]

7. TH USE OF GEOGRAPHIC INFORMATION SYSTEMS (GIS) IN SURVEILLANCE

Since this disease cholera has been a major public health concern especially in Nigeria, the Nigerian Centre for Disease Control (NCDC), has now started the implementation of the innovative approaches to tackle the disease. These include: “The use of innovative technology and data to strengthen disease surveillance by ensuring that early detection and prompt responses are made. The improvement of coordination for technical support, resource mobilization, and partnership. The adoption of a multi-sectorial approach to meet the 2030 cholera elimination by working with the environment and WASH sectors to ensure that communities have good water and sanitary facilities which will prevent further outbreaks”. This model seeks to improve on John Snow’ 1854 cholera model, which used statistical analysis to establish a link between the cholera cases reported from an outbreak around the

Broad Street pump and the source of water consumed by the people. The NCDC and eHealthAfrica (eHA), in a synergistic relationship, adopted Snows approach, and improve on it by using advanced geographic information systems (GIS) technologies. The eHA uses positive outcomes from data and tools to help ameliorate the health of the people. They are specialized in the design, evolution, corroboration, and elaboration of prognostic models for diseases such as cholera [27].

GIS is used to investigate distinctive geographical points to derive information that can give a clue to the information needed to take decisions on best plan public health intervention strategies. Geographic Information Systems Focuses on Health Delivery Systems, Public Health Emergency Management Systems, Disease Surveillance Systems, Laboratory & Diagnostic Systems, and Nutrition & Food Security Systems. This has enhance data management within the NCDC National Incident Coordination Centre (ICC), (the emergency operations center for coordinating disease outbreaks at the national level). It has helped to map out cholera persistent areas (cholera hot spots) across Nigeria's Local Government Areas (LGAs). This also gives an insight to the areas that need vaccination as well as the required amount of vaccines needed per LG, at the onset of an outbreak [27]. The basic purpose of GIS is that it merges information, technology, and operations together to provide swift answers to the health needs of the local and/or unmerited communities, using software and data to capture, manage, analyze, and display geographic information about the physical and social environment. GIS data is very necessary in the capture of unrecorded dwelling places, micro planning of vaccination campaigns, and mapping exact plan for the administration of vaccine. For example, GIS has been used to map out boundaries for all administrative regions in Nigeria, the positions of 100,000 health facilities, 500,000 settlements, and 200,000 kilometers of roads [28]. The NCDC, and eHealth Africa, in response to the 2018 cholera outbreak in Nigeria, used the scan statistics approach to analyze data from previous cholera outbreaks, conduct a hotspot mapping of cholera, distinguish distinct runs, important cholera persistent areas, and approximate threat across the nation. The ICC then used this information to more importantly plan the reaction and share materials to assist the areas in distress. The GIS can be implored to help in the contagious disease forecasting, finding, and reactions in all environments. For underserved remote communities, it can be metamorphosed to look at other related public health threats, giving information on the relationship between natural disasters, relief efforts, and the public health response, help plan for alternative delivery routes, ensure that commodities such as vaccines or clean water get to at-risk, post-disaster and hard to reach communities. It helps to encourage proactivity, rather than reactivity [29].

8. The USE OF AETHER AND GATHER FOR SURVEILLANCE

For effective health interventions medical data must be promptly disseminated and easily distributed between health organizations and their partners taking into cognizance the guarantee for security and privacy. eHealth Africa has developed reliable and secure platforms such as Aether (which enables organizations to build solutions that curate and exchange live information) and Gather (a versatile data collection and curation tool) Which is built on top of Aether. Gather makes sure that data is securely collected in the field and distributed immediately to areas where it is necessary. It can interoperate separately planned information collected in the field, merge them with other systems and arrange them for data management, transformation and analysis, and securely send them using cloud environments or on-premises deployments. For example, Sierra Leone, in 2018, the CHAMPS (Child Health and Mortality Prevention Surveillance) network uses Gather to accumulate information to identify and prevent child death while in Nigeria, the GRID (Geospatial Reference Information Data) project uses Gather to collect spatial reference data and other points of interest such as health facilities, schools, markets and post offices to create a geo-database, that the government uses for data-driven decision making. Furthermore, in the Democratic Republic of Congo, the DRC Micro-census project used Gather to conduct a micro-census in the region of Kinshasa and Bandundu to predict how many people live in each settlement and estimate the total population for DRC; an information that is playing a vital role in the current Ebola outbreak [30].

9. THE USE OF VACCINATION TRACKING SYSTEM (VTS or VAXTAC) IN SURVEILLANCE

Vaccination Tracking System (VTS) ware developed in 2012 to take care of the lapses that were encountered during Supplementary Immunization Activities (SIAs), especially in low resource settings which needed effective tools that will help in keeping records of the children registered for vaccination and tack their immunization records, to improve vaccination coverage. VTS enables healthcare providers and associates with daily knowledge of the work of vaccination teams during SIAs, by collecting passive tracks of the vaccination teams using android phones (GIS technology-enabled) and forwarding them onto a screen for visualization. This gives those concerned, the close to approximately-real information about the geo-coverage of the vaccination campaign. The system also spots out left out residential areas every day, to enable prompt action on the inclusion of the settlements in the ongoing campaign. The VTS also adds to the accountability of vaccination teams and this most especially decreases the hazard of getting fake information [31].

10. ELECTRONIC INTEGRATED DISEASE SURVEILLANCE & RESPONSE (eIDSR)

The Integrated Disease Surveillance and Response (IDSR), is an initiative of the WHO AFRO which was established in 1998. Strategically, it is guided by the WHO Regional Office for Africa (WHO AFRO) to prevent and control these multiple epidemic emergencies [32,33]. Its main aim is strengthen national public health surveillance and response systems in the area, with the specific objectives of: 1) integrating vertical disease surveillance systems for effective and efficient use of resources; 2) improving the dissemination and use of data for detecting and responding to public health threats; and 3) improving the ability of the country to detect and respond to major public health problems [34]. The IDSR, while depending on systematic and continuous data collection and reporting by health care facilities, performs the duties of identification, notification, analysis/ and interpretation, epidemic investigation/confirmation, preparation, response, circulation of information/evaluation, improvement of the system, and carrying out WHO AFRO recommended surveillance on some major communicable diseases. This prompt intervention strategies place public health decision taking in the countries involved, at a higher degree. This lead epidemiological role taken by IDSR in disease outbreak prevention and control, has led to its being implored in evaluation of the spatial and temporal dynamics of various diseases [34].

Despite its credibility in the production of reliable information, IDSR is expensive and produces a lot of irregularities in reported morbidity and what is actually obtained in the field. This therefore, creates some level of distrust in the epidemiological studies using IDSR morbidity data [34].

The amalgamation of different bodies (U.S. Centers for Disease Control and Prevention, eHealth Africa and the Ministry of Health and Sanitation), gave birth to a new body called the electronic Integrated Disease Surveillance and Response system (eIDSR), which is a purpose-built digital data collecting and reporting tool whose main purpose is to improve the flow of information within health systems. eIDSR, transmits data into the web-based District Health Information System (DHIS2) (which serves more than 45 countries) [35]. Through the compatibility of eIDSR with the health information system DHIS2, dashboards, visualizations and reports, knowledgeable conclusions can be taken. Such decisions that will aid the health system include; skill acquisition programs that will assist in solving the problem of connectivity/continuous unavailable power supply, followership, as well as the supply/distribution of resource materials and hardware. eIDSR connects the health system to bring out a formidable evidence about the true health situation of the area in question. The system can be used even when there is no readily available power supply. This is because it can hold available information and deliver it immediately when there is internet connection and power supply, through short message service (SMS) [36].

The manual of Paper-based methods is full lapses (time consuming, full of errors etc), and since it is usually dependent on the availability of power supply, which is often lacking in the rural communities, the accuracy of the data submission is improved through the use of internet, smartphone SMS, or saving data offline, to be made available whenever the is connection. This gives some level of credibility,

elaborate completion and tending of information from the community level up to the national level. Furthermore, information reaches its destination faster, new field workers are easily trained health decisions are taken without waste of time, in case of potential disease outbreak. It enables prompt and efficient decisions to be taken concerning the collection and reporting of data; real time action when it concerns disease investigation and reporting. This therefore, brings improvement to the health system, health communication, and health information management, at ministry level.

This system also, though efficient, is faced with challenges such as; issues with data quality and consistency, data security, manual aggregation process, timeliness of reporting and scarcity of internet connectivity. These problems have been counteracted by the provision of a Windows application which eases case entry at the district level by allowing the District Surveillance Officers to render cases locally without internet connection [36].

According to report from a cross sectional study carried out in Sierra Leone, Geason et al. [35], stated that, eIDSR improved the timeliness and accuracy of surveillance data. In this report it showed that in 2016, district-level eIDSR was piloted and then spread out to all fourteen districts, where the Health Facility (HF) staff calls the District Health Management Team (DHMT) staff, who then enters the information directly into the national District Health Information System (DHIS2) database. This was again done in a facility in just a single district from 2016–17, and in 2018, it was done in facilities Nationwide in Sierra Leone. The results indicated that eIDSR, IDSR reporting rose from less that 40% of HF in 2016 to more than 97% in 2017, and the increase, was maintained in 2018. The data-entry time was reduced by 63%, errors reduced by 45% and 12% accuracy increase [35,37]. In 2017, 44 out of 47 countries (94%) were already implementing IDSR by December, but only 33 (70%) had eIDSR [33].

11. HEALTH DELIVERY SYSTEMS

These health delivery systems make use of a data based, solution system technology, which focuses on improving health delivery to people in vulnerable communities and underserved populations. The use of LoMIS as a tool that allows Health Officers to submit reports on their mobile devices such as twitter, helps supervisors view important vaccine stock and consumption matrices in real time. With this tool, more and efficient online training resources are easily made available to Community Health Officers (CHOs). For example, this has greatly elevated the reliability of vaccine delivery services in Kano, Bauchi, and Sokoto states, where Kano state alone, about 1,400 Android phones (each equipped with Open Data Kits (ODKs) have been handed to Healthcare Workers to ease the submission of data via questionnaires.

Another tool used is the Vaccine Direct Delivery (VDD) , which is a third party logistics service made available to the State Primary Healthcare Development Agencies, to assist in perfect and better dissemination of vaccines and other resources from state cold store to health facilities at the ward level.

Furthermore, a modified electronic version of the Service Ability and Readiness Assessment (SARA) has been provided by eHA to aid in the tracking and provision of data by the CHOs [38].

12. GEO-REFERENCED INFRA-STRUCTURE AND DEMOGRAPHIC DATA FOR DEVELOPMENT (GRID3)

The Geo-Referenced Infrastructure and Demographic Data for Development (GRID3) is a project that is created with the aim of collecting accurate, complete, and geospatially referenced data that involves settlements, health facilities, schools, markets, roads, water points, and farms etc. that are important requirements to several regions across Nigeria [38].

The Field Epidemiology Training Program (FETP), is another service-based training program provided by eHA, for training public health workers in the principles and practices of field epidemiology. While the World Food Program (WFP) in partnership with eHA, uses either food or cash transfers to support vulnerable populations affected by the violence in Northeast Nigeria. They set up and managing warehouse facilities across the region. MEDSINC which was designed by THINKMD, is used by frontline health workers—Community Health Workers (CHWs) to perform an integrated illness severity assessment for respiratory distress, dehydration, sepsis, malnutrition (none-moderate-severe) and other childhood illnesses [38].

13. AUTO- VISUAL AFP DETECTION AND REPORTING (AVADAR)

The eHealth Africa (eHA) in partnership with the World Health Organization (WHO), the Novel-T, the Bill Melinda Gates Foundation (BMGF) and the Ministries of Health in eight countries including Chad and Niger, formed the AVADAR. This was to help in checkmating the short comings encountered with inter-sectorial disease surveillance coverage and manual documentation errors by the disease surveillance officers (DSOs). This mergers, relieved the DSOs in case identification and reporting, since local communities and enlisted members, serve as informants and investigators. Also, infused digital data management and reporting innovations through the mobile application help these community informants, report cases via the AVADAR mobile application. The investigators also, receive alerts of these reports on their mobile devices, locate the cases, investigate and collect stool samples for further laboratory tests [39].

14. THE ROLE OF GOVERNANCE AND NATIONAL STRATEGY IN CHOLERA PREVENION AND CONTROL

14.1 The Word Health Oganization (WHO)

One World-One Health is an interdisciplinary, complete and unified system of approach that contributes to the search for solutions to health problems through disease surveillance, outbreak investigation and response activities undertaken by professionals from various fields. It ensures that there is sustainability and relationship among these sectors, a condition that promotes better management of the limited materials, appropriate and timely distribution for efficient disease prevention and control. The mission of the World Health Organization (WHO) is "the attainment by all peoples of the highest possible level of health" (Article 1 of WHO Constitution). The WHO country office, in conjunction with the Country Cooperation Strategy (CCS) have issued some major important guides, and these include:

i) "disease prevention and control (reduction of excess mortality, morbidity and disability, especially in poor and marginalized populations; promoting healthy life styles and reducing risk factors to populations;)
ii) strengthening health systems that equitably improve health outcomes and responding to people's legitimate health demands;
iii) strengthening partnership in the health sector; (thereby promoting effective health dimension to social, economic, environmental and development policies) and
iv) Strengthening emergency preparedness and response programs, to address the country's increasing vulnerability to natural and man-made disasters".

The WHO and UNICEF usually associate with Ministry of Health to react to issues concerning disease events and outbreaks. Meanwhile, Local Government authorities and districts have developed plans that will enable them to respond appropriately in case of an outbreak. But where that is not available, the national strategic plan also serves as a reference, in the absence of a district specific action plan [40].

To ensure that the needed resources are appropriately distributed and effective for the diagnosis, confirmation of cholera outbreaks, and the treatment of cholera patients.

On the whole, a total of 6 onsite cholera test kits, developed by WHO are now available after due revision in 2016. They include; 1 for investigation, 1 with supplies for laboratory confirmation, 3 for treatment at the community, peripheral and central levels and contain enough material to treat 100 patients and 1 support kit with logistical materials (solar lamps, fencing and water bladders and taps).

These revised cholera kits have been designed for emergency preparedness in case of a potential cholera outbreak, to assist during the first month (holding time) of the initial response [41].

15. THE NIGERIAN CENTER FOR DISEASE CONTROL AND PREVENTION (NCDC)

The NCDC, since 2011, under the leadership of the Federal Ministry of Health, has been in charge of diagnosing, evaluating, preventing and reducing the incidence of diseases of national and international public health significance, including cholera. It has the capacity to establish a Public Health Emergency Operation Centre (EOC), to be in charge of the reactions that come in during significant epidemics, as was seen with

the 2018 cholera outbreak. This EOC which is led by the Commissioner of Health and by the Director of Public Health if he is absent (under the direct coverage of the State Ministry of Health) is in charge of the application of strategic plans at the state level. It provides a multi-sectorial coordination mechanism to oversee the whole application of the emergency and prevention plans in reaction to cholera outbreaks, and other key health threats. The EOC includes; surveillance/epidemiology, laboratory diagnosis, case management, risk communication/social mobilization, Water, Sanitation and Hygiene (WASH).

The Federal Ministry of Water Resources directs the water, sanitation and hygiene component of the response. The WASH Sector brings out a list of field associates, successes and lapses that can be incorporated into the general Monitoring & Evaluation (M&E) at the EOC. The National Primary Health Care Development Agency, operates vaccination campaigns in the affected states [42].

16. CENTER FOR DISEASE CONTROL AND PREVENTION (CDC)

"Key Messages from CDC: Protect Yourself from Cholera"

1) Drink and use safe water.

Safe water should be used to brush the teeth, wash and prepare food, and to make ice. Bottled water with unbroken seals and canned/bottled carbonated beverages are safe to drink and use. Food preparation surfaces, environments and kitchenware should be cleaned with soap and safe water and left to dry completely before reuse. *Piped water sources, drinks sold in cups or bags, or ice may not be safe and should be boiled or treated with chlorine.*

Water may be treated by boiling for at least 1 minute or with a chlorine product such as Aquatabs®, Dlo Lavi, Gadyen Dlo®, PuR® or household bleach, to make it safe to drink and use. About 8 drops of household bleach for every 1 gallon of water (or 2 drops of household bleach for every 1 liter of water) and wait 30 minutes in a clean covered container, before drinking.

2) Wash hands often with soap and safe water.*

The CDC advices and encourages hand washing with clean water and soap before the preparation and eating of food, feeding of children, after using the latrine or toilet, cleaning the child's bottom, after taking care of someone who is ill with diarrhea.* *in the absence soap, ash or sand can be used to scrub the hand before rinsing with safe water.*

3) Use latrines or bury feces (poop); and avoid defecation in any body of water.

The use of latrines or other sanitation systems, like chemical toilets, to dispose of feces is encouraged. These latrines and surfaces when contaminated with feces should be cleaned with a solution of 1 part household bleach to 9 parts water. New latrines or temporary pit toilets should be dug at least half a meter deep and 30 meters away from any body of water, and defecation also, should be done at least 30 meters away from any body of water and the feces buried properly. If there are, any plastic bags containing feces in latrines, they should be dropped at the collection points if any, or buried in the ground.

4) Food Safety

Boil it, Cook it, Peel it, or Leave it (BCPL). Proper cooking of seafood, especially shellfish, eating food hot, peeling fruits and safe washing of vegetables is also encouraged. * *Avoid raw foods other than fruits and vegetables you have peeled yourself.*

5) Clean up

Bathing and washing of diapers, and clothes, has to be done 30 meters away from drinking water sources" [43].

17. UNICEF HEALTH RESPONSE

UNICEF, Plays a very important advocacy role towards the eradication of cholera by using the team spirit policy on responses. In partnership with the affected countries, (the case of Kenya), UNICEF partnered with the Red Cross Society and through integrated Health, WASH and C4D interventions, they improve the management of cholera treatment centers, treatment units, hygiene promotion, community health volunteers, and dispatch of assorted supplies to affected counties. They respond to anticipated cholera outbreaks due to, escalating drought, by distributing emergency cholera and drought response packages to affected countries especially in cholera hotspots (eg. in Western

Kenya, and in Kajiado County). UNICEF has also taken up the responsibility of providing household water treatment and supply facilities which can support about 3,900 households to access safe water that can be used by approximately 19,500 inhabitants. They help the various areas to actualize the Cholera Prevention and Control Action Plan and carry out joint visits to the cholera hotspots [3].

17.1 Ending Cholera: A Roadmap to 2030

In October 2017, a strategy for cholera control, ending cholera; a global roadmap to 2030, was launched by a mergers called the Global Task Force for Control of Cholera (GTFCC). They aim at bringing down cholera deaths by 90% and to eradicate cholera in as many as 20 countries by 2030. The strategy has the objectives of;

1. Implementing a multi-sectorial approach to cub the disease through early detection and quick response; including community engagement, strengthening surveillance and laboratory capacity, health systems and supply readiness, and establishing rapid response teams.
2. Implementing a focused multi-sectorial approach to avoid subsequent cholera recurrences, by sensitizing nations and associates to base their efforts on cholera persistent regions, encourage break in transmission through improved WASH and use of OCV.
3. Implementing an efficient method of providing for technical support, mediating, distribution of materials, and liaising at local and global levels Global Task Force on Cholera Control [44,10].

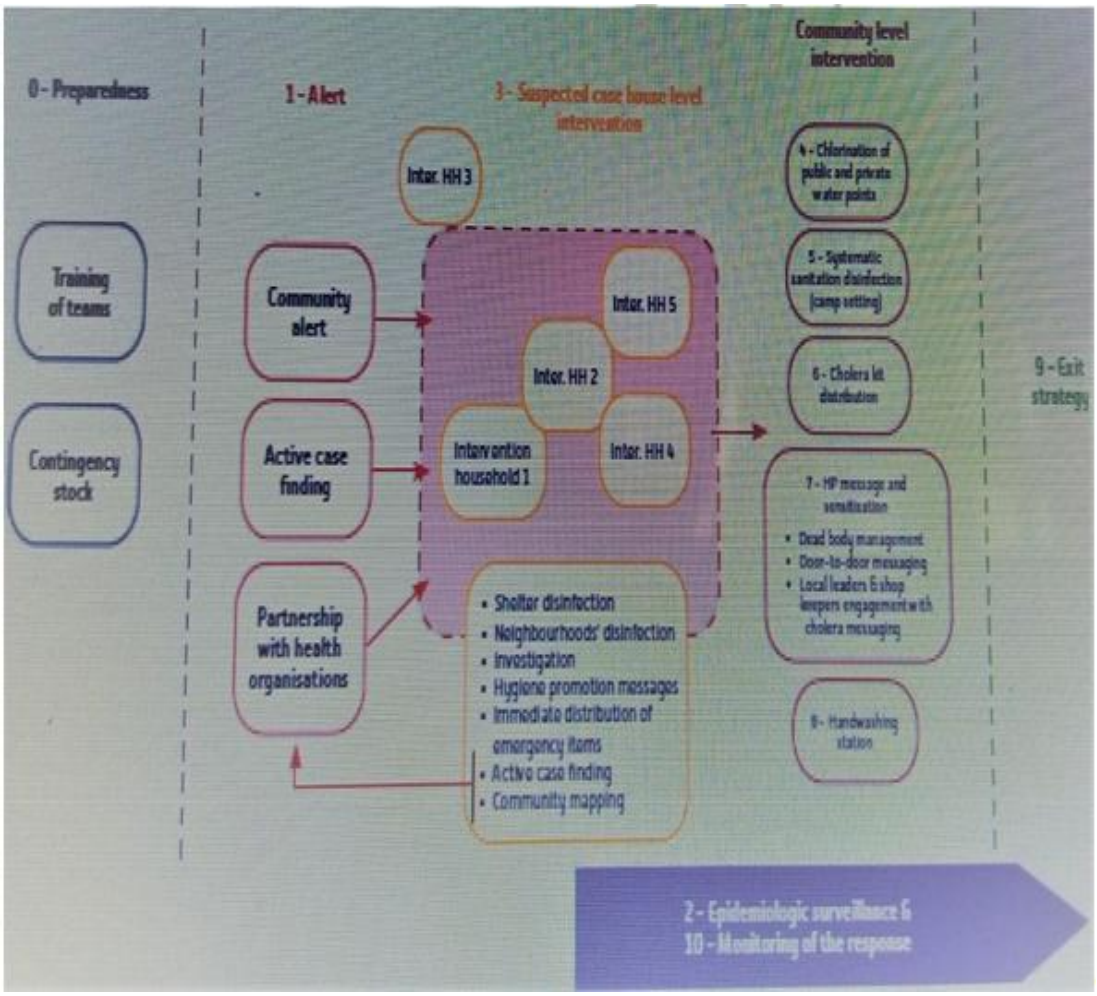

Fig. 1. Solidarités international's approach and methodology
Source: [42]

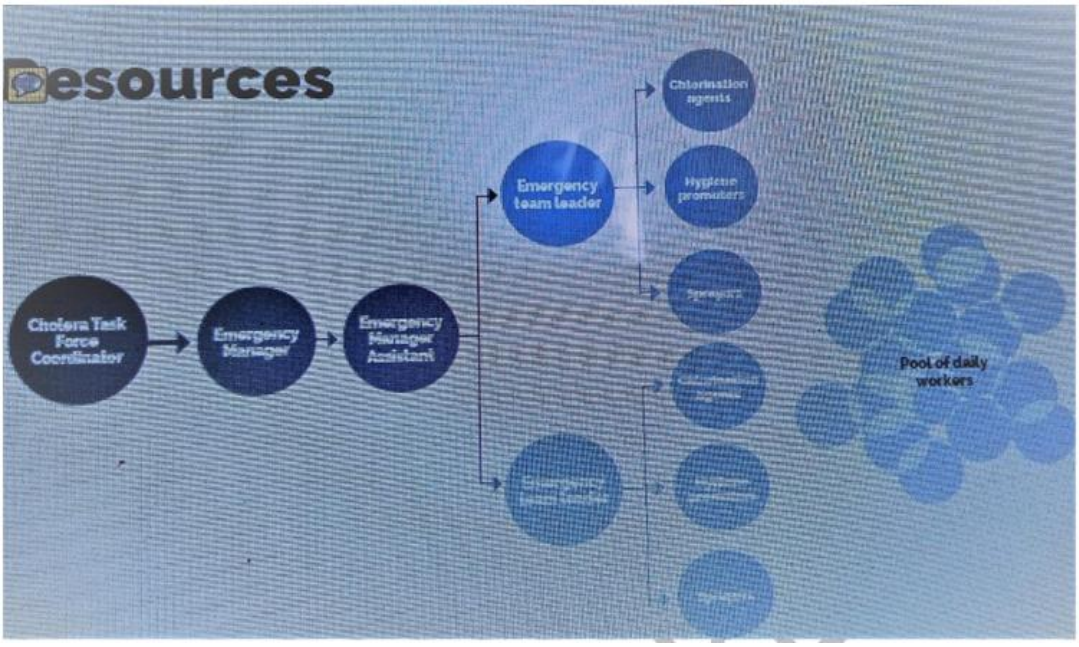

Fig. 2. Solidarités international's surveillance team
Source: [42]

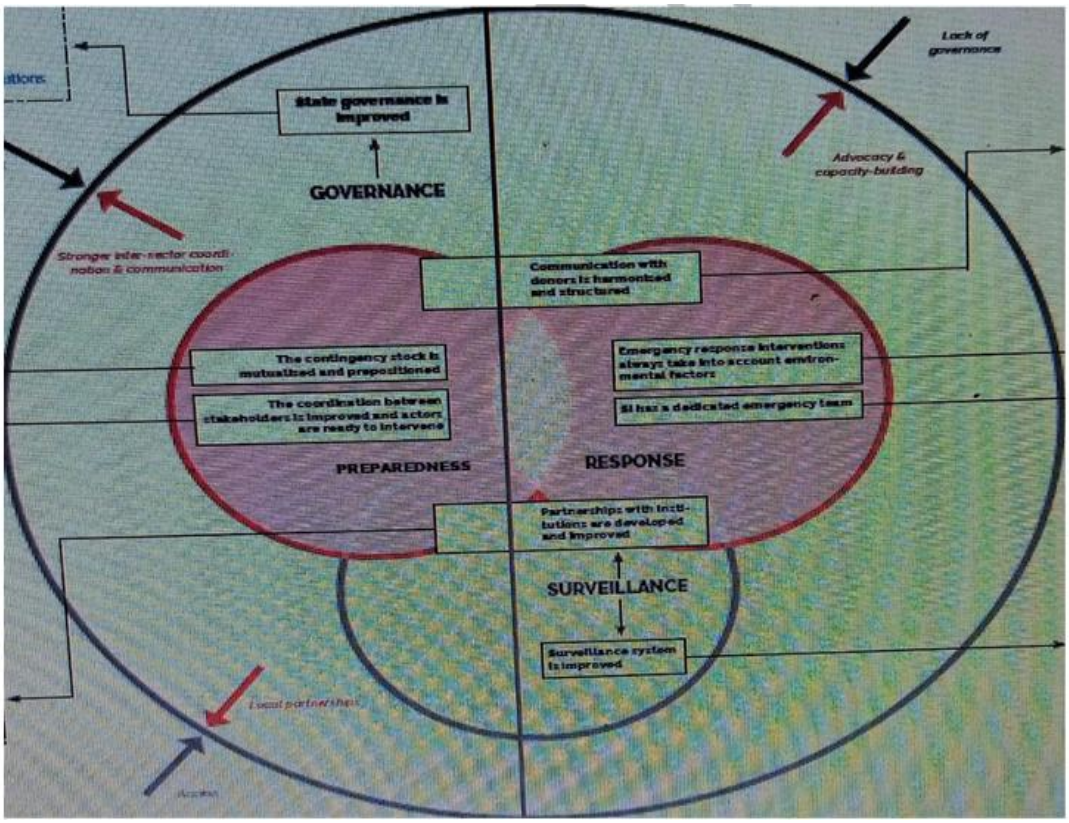

Fig. 3. Cholera emergency needs
Source: [42]

18. SOLIDARITÉS INTERNATIONAL'S

18.1 Cholera Preparedness at Coordination Level

Established in Borno State since 2016, Solidarités International (SIs) intervened in the primary cholera outbreak that occurred in the state in 2017 by making available to susceptible areas, a multi-sectorial, life-saving humanitarian aid, especially to the Internally Displaced and host communities who suffer from disease outbreaks.

In April 2019, the Cholera Technical Working Group ("Cholera Task Force") first led by Solidarités International organization in Borno State, evolved from an initiative by the WASH Cluster. Their major objective is to organize cholera preparedness and response among associates and the government in Northern Nigeria. This is a forward effort that allows them to cooperate with medical actors in Cholera Treatment Centers and Units to always get current information on cases from the Ministry of Health and WHO and share with partners in order to ensure a quick response to cholera outbreaks. The preparedness activities under SI's leadership of the cholera Task Force include the following:

- They bring out a clear picture of all associated groups and possible activities per area of intervention (per LGA, ward and community);
- They pinpoint the loop holes in chlorination in cholera persistent areas and ask for immediate cover up by the other partners;
- They contemporize the Cholera preparedness and response plan;
- They take stock of the available resources;
- They take the responsibility of drilling the other associates on WASH Standard Operating Procedures (water chlorination, household disinfection, hygiene promotion); and Create a recording screen on behalf of the WASH sector for reporting the weekly work done by the other associated groups and the site where the cases were treated at the facilities.

18.2 Cholera Prevention Activities by Solidarités International

The major focus of SI in the activities geared towards the prevention of cholera is, on establishing and maintaining the traditional WASH activities in potential areas. They create or rejuvenate water point committees, build new, refurbish old facilities, provided chlorine for chlorination, conducts regular campaigns to clean jerry cans at water points, forcefully scatter toilets in overpopulated areas, create and clean sewage drainages. All these efforts are made to ensure that there is increase access to good quality pathogen-free water and sanitation to the community in question and hence prevent diarrheal disease outbreaks.

18.3 Emergency Cholera Response

There is a SI Emergency team that responds to cholera signals by distributing contingency stocks (including cholera kits, packs for the chlorination of water points, disinfection of households, CTC and CTU within 12 hours and within a radius of 30 meters), training of field teams in each LGA and training/ mobilization of community members who perform chlorination of water points or disseminate hygiene promotion messages and conducts a profound search to get the source of infection and attempt a solution. Finally they access the water quality by detecting the level of Free Residual Chlorine (FRC), which must not be below 0.5 mg/l. A trained toilet cleaning committee is furnished with cleaning kits (1 kit for10 households in small informal IDP camps,1 kit for 3 blocks of latrines in formal camps), while the Hygiene Promotion team distributes household kits for water treatment, hand washing and general hygiene. Making available at least 900 cholera kits, chlorine for disinfection and water point chlorination, and protection equipment for disinfectors and chlorinators. The soap and Aquatab quantities are sized based on an average of 6 persons per household of 30 meters radius for hand washing. The community leaders are also schooled on how to treat and manage dead bodies during burials and disseminate information. This is achieved through the coordinated action of the C4D department of UNICEF which makes good use of information and communication technologies, such as mobile phones, U-report etc.

18.4 Weaknesses of SIs

Some of the weaknesses observed with the SIs come from coordination between actors at LGA level and this opens up loop holes in cholera interventions. Also, late referral from health partners causes serious stretches between the emergence of a signal cases and response.

A host of partners cannot intervene from the beginning of the outbreak because they cannot afford the capacity due to inappropriate, lack and delay of financial assistance.

Sometimes civil unrest, instability, insecurity, violence etc. causes displacement of government representatives mostly from the LGAs and this subsequently results to basal level of involvement in these areas.

19. PUBLIC HEALTH EDUCATION AS A PREVENTION STRATEGY

It is worthy of note that, often, there is little community awareness and limited understanding of the role and connection between poor sanitation and poor health. Health education therefore, seems to be the way forward, as one of the strategies towards the prevention and the spread of such diseases as cholera. Changing the mindset of people is a gradual process [45], and may therefore, require the participation of Media, community and religious leaders to participate in health education and social mobilization campaigns [46]. This will go a long way to assist the population to understand when and where to report cases and to seek immediate treatment when symptoms appear as well as the location of appropriate treatment sites [41].

20. THE IMPLEMENTATION OF WATER, SANITATION AND HYGIENE (WASH) PROMOTION AS PREVENTION STRATEGIES

A safe water supply and adequate sanitation and hygiene are the major WHO recommendations for cholera prevention [47]. Universally, WASH activities are recognized as a strategic part of disease control and prevention [48,49,50]. It is important to note here that, about 97% of cholera outbreaks can be prevented through drinking safe water, observing basic sanitation and appropriate hygiene behaviour. This is one of the major reasons why there are water- treatment plants, food-preparation and sanitary facilities spread throughout the developed countries where almost zero incidence of cholera is often recorded [51].

20.1 Safe Drinking Water— Aquatabs

Since it has been noted that cholera can be spread by drinking and using water that has been contaminated by *Vibrio cholerae* germs, it would obviously be better, to use safe water (water that is bottled with an unbroken seal, boiled, or treated with a chlorine product) for drinking and other household activities because this will help to prevent the spread of cholera [52]. Aquatabs® (small tablets of chlorine that come in a foil strip in 5 different strengths), is a product which is often put into water in contained a clean covered container, that has a tap as water treatment. A packet of this product in the bucket of water, stirred with a clean utensil is left to stand covered for 30 minutes before drinking or using the water. The water is usually drunk and used within the next 24 hours and a fresh preparation made especially if the container is not covered. If the container is covered and has a tap, treatment is done just once till the water is finished [53].

20.2 Dlo Lavi and Gadyen Dlo

Dlo Lavi and Gadyen Dlo® are liquid chlorine water treatment products that come in a small bottles. One capful of these products makes 20 liters (5 gallons) of water safe for drinking. The Dlo Lavi liquid is poured into the cap from the Dlo Lavi bottle (1 capful into a clean container with 20 liters (5 gallons) of water or, 2 caps full, if the water is cloudy. This is then stirred, covered and kept for 30 minutes before drinking or using the water which remains safe for safe water in the next 24 hours, same as with aquatabs [53].

20.3 PuR®

PuR® is a water treatment product that is best for dirty or cloudy water. This is because it has the capacity to clarify and also disinfects the water, while other products have the ability to disinfect the water without clarifying it (leaving it still dirty and cloudy). PuR® comes in a small packet or sachet and one of these sachets makes 10 liters (2 ½ gallons) of water safe for drinking. When a single sachet of PuR® powder is put into a container with 10 liters (2 ½ gallons) of water, stirred with a clean utensil for 5 minutes and left to sit for 5 minutes (for sedimentation of flocks), followed by filtration through a clean cloth into a clean container with a lid and left to stand for 20 minutes, this will make the water safe for drinking and use in the next 24 hours. If container that is not covered, the water will need to be treated after every 24 hours interval [53].

Table 1. Making water safe with aquatabs®

Aquatabs® Tablets		Number of tablets to use		To make this much water safe	
Strength	Color of Packet	Clear Water	Cloudy Water	Liter	Gallon
8.5 mg	Yellow packet	1	2	2.5 liters	½ gallon
17 mg	Green packet	1	2	5 liters	1 gallon
33 mg	Green packet	1	2	10 liters	2½ gallon
67 mg	Blue packet	1	2	20 liters	5 gallons
167 mg	Red packet	1	2	40 liters	10 gallons

Source: [53]

20.4 Safe Water Storage

One major characteristic of safe water is that it is stored in a container that stops germs from getting into the water once water has been made safe to drink. The major source of germs in drinking water include; people's hands, cups, utensils, and other objects. Thus storage of treated water in closed containers with tap or small opening that stops people from dipping their hands, cups, utensils, and other objects into the water, is the most important way to prevent the spread of cholera and other water borne diseases [53].

20.5 Care of the Storage Containers

The container is washed with soap and safe water, cleaned with 1 part household bleach to 100 parts water mixture. It is then covered and shaken vigorously, so that all inside surfaces of the container are touched. This is then kept for at least 30 seconds before pouring the water mixture out of the container and left to air dry. If there is no household bleach available, the container is cleaned with soap and safe water and let to air dry before use [53].

20.6 Hand Washing

Cultivating the habit of washing the hands with soap and safe water often, helps to protect people themselves and their families from cholera and other diseases. Dirty (or poorly washed) hands can transfer cholera germs to food, water, and household surfaces. Thus hands should be washed often, especially: Before eating or preparing food, feeding children, after using the latrine or toilet, cleaning the child's bottom and after caring for a diarrheal patient. Good hand washing practice entails that the hands be wetted with safe water, lathered thoroughly with soap or scrubbed with ash or sand (if there is no soap), rinsed well with safe water and completely towel dried with a clean towel, or air dried in the absence of a clean towel [53,54].

20.7 Safe Food Preparation

Contamination of food and water with cholera germs can come from the feces of a cholera patient, through improper handling of the food and water after taking care of a patient. Washing of the hands often with soap and safe water when preparing food, use of safe water for food preparation, thorough cooking of food (especially fish, shellfish, and vegetables), eating cooked food HOT, storing cooked food in covered containers, reheating cooked food well, cleaning food preparation surfaces/kitchen utensils with soap/safe water and eating only food from trusted sources, will go a long way to prevent contact with *V. cholerae* pathogens [53].

20.8 Safe/Efficient Excreta Disposal Systems (Safe Sanitation)

The safe disposal of wastes, especially excreta, is another key aspect of cholera disease prevention, considering the fact that *V. cholerae* can be spread from human faeces, which contaminate either water or food [45]. When feces (poop) or vomit from an infected person gets into food or water that another person eats or drinks especially from dishes, furniture, floors, or bedding materials, healthy people can be infected if they get in contact with these items and then touch their mouths [53].

Safe sanitation, which means that feces (poop) are properly disposed of in toilets or latrines, or buried, can help prevent the spread of cholera. To observe safe sanitation practices, hands must be washed with soap and safe water after defecating or after handling feces (poop) of an infected person. Latrines or other sanitation systems, like chemical toilets or pit latrines, must be used to dispose of feces (poop) and vomit. Defecating should be at least

30 meters away from any body of water or feces should be buried under the soil, not defecating in rivers or streams. Furthermore, new latrines or temporary pit latrines must be dug at least a ½ meter deep and at least 30 meters away from any body of water [53].

Latrines and surfaces that have been contaminated with feces (poop) or vomit, must be disinfected using a solution of 1 part household bleach to 9 parts water [55]. P20 minutes plastic bags containing feces (poop) and vomit should be disposed in latrines, at collection points, if available, or buried in the ground at least 30 meters away from any body of water, not put (the plastic bags) in chemical toilets. If bags are used inside a bucket, the bucket should be cleaned and disinfected daily with a solution of 1 part household bleach to 9 parts water [53].

20.9 Safe Cleaning and Bathing

Regularly safe cleaning of household surfaces and other items as well as having a good bathe, can avoid exposing family members to feces (poop) and vomit. Washing of bedding, clothing, and diapers with soap at least 30 meters away from all bodies of water with 1 part household bleach to 100 parts water mixture or soaking in boiling water before washing with soap and drying in the sun, bathing of self and children with soap and water at least 30 meters away from all bodies of water, and disinfecting mattresses by drying well in the sun can bridge the transmission link and hence prevent the spread of cholera. [52].

20.10 Preparing a Body for Burial When a Person with Cholera Dies at Home

In case of a cholera death, the body releases fluid that may be infectious (contain *V. cholerae* pathogens). The mortal remains must not be kissed, touched, or held by any family members, friends, and neighbors. Therefore, the local officials or a health care workers must be contacted immediately to specially handle and prepare the body for burial and funerals held within hours of death, if possible. The mouth and bottom (anus) must be filled with cotton that has been soaked in a solution that is 1 part bleach to 9 parts water [55], and the body put in a bag to prevent infectious fluids from leaking out. The hands should be well washed with soap and safe water after preparing the body, clean all of the deceased person's clothing and bedding with 1 part household bleach to 100 parts water mixture and drying in the sun or if possible, stir the bedding and clothing in boiling water before washing. Mattresses also, can be disinfected by drying well in the sun while surfaces such as table tops, vehicles, etc. that the body touched can be cleaned with a solution that is 1 part bleach to 9 parts water. Those who prepared the body must not prepare food on that day, drink and use safe water for all household uses and store safe water in a clean, covered container [53].

20.11 Preventing Cholera Stigma

A poor understanding of health hazards and pre-existing prejudices, can cause people to promote fears, rumors, myths, shaming, name-calling, shunning, teasing, rejection, and abuse of cholera sufferers and their families. Thus resulting to a cholera stigma during a disease outbreak. It labels people as different giving a negative impression about someone (because he is dirty and was infected with cholera).'This causes those people involved to feel rejected, withdrawn, isolated, gossiped, violated, blamed and discriminated. Educating the community on the disease, its causative agent, its mode of spread, presenting healthy, previously treated cholera victims, giving health talks, maintaining a sense of calm when working with cholera sufferers and their families, can help to prevent cholera stigma [53].

20.12 Helping the Community to Fight Cholera

The major role we need to play in community mobilization during a cholera outbreak, is to help our families and friends adopt cholera prevention and health-seeking behaviors, so they can stay and remain healthy. This will involve schooling them about cholera, the key cholera prevention actions, promoting cholera prevention, control, and health seeking behaviors, practicing new skills for cholera prevention, connecting families and friends to health services, encouraging positive attitudes, being supportive of people sick with cholera/their families and correcting misinformation and myths [52,56].

21. CHOLERA CONTROL STRATEGIES

21.1 Oral Rehydration Solution

Dehydration, the loss of water and salts from the body, often occurs during watery diarrhea

(cholera). During this process, there is usually loss of water salts and electrolytes that can lead to death [57]. Oral rehydration solution (ORS) are usually given to replace the lost water and salts [58]. However, it is important to note that drinking ORS will not prevent or immediately stop diarrhea, but they can save life (both for adults and children) [52,57].

Since one of the most pertinent symptoms observed with cholera disease is aggressive depletion of water volume from the patient, that often results to hypovolemic shock and subsequently death, the best way too, to handle the case and rapidly restore circulation, will be an aggressive repletion of fluid, ether orally, or intravenously [41,59]. The volume and type of fluids to be administered will depend on the level of volume depletion. This is because, at the onset of treatment, an initial fluid volume of 100 mL/kg, given over three hours (or five hours for infants), with 30 mL/kg given over the first half-hour (or first hour for infants) can arrest the condition. But patients with severe cholera would definitely require a mean volume of 200 mL/kg of isotonic oral or intravenous fluids in the first 24 hours of therapy and above 350 mL/kg. Assessment of fluid loss is usually done by simple examination of the mental status, eyes, mouth, skin, and pulse rate of the patient [60].

By the WHO standard, the level of depletion is categorized as follows; criteria of none (<5 percent of body weight), some (5 to 10 percent), or severe (>10 percent) based on physical findings. Cholera cots, though very inexpensive to get, are useful for estimating continued volume losses in stool. However, in the absence of cholera cots, continuing losses can be estimated as 10 to 20 mL/kg of body weight, for each stool or episode of vomiting. The deficit fluid volume should be replaced within three to four hours of presentation [61], especially in severe volume depletion (usually >5 percent), where fluid losses are typically of 10 to 20 mL/kg/hour, with greater electrolyte losses in the stool [60]. Appropriate management of fluid losses reduces the mortality of severe cholera to less than 0.2 percent. For patients with some volume depletion, the WHO in 2002 recommended the reduced osmolar ORS, on the grounds that, it has been demonstrated to decrease stool output, vomiting, and the need for supplemental intravenous fluids [41,62,63,64].

For cholera subclinical hyponatremia, ORS formulation has been recommended by WHO, while a rice-based ORS containing rice powder instead of glucose, has proven to be better in the reduction of the duration of diarrhea and stool losses in severe cholera. Also, the best commercially available intravenous solution for this purpose is an intravenous Ringer's lactate, because it contains potassium and sodium bicarbonate, which are both lost in cholera stools. However, there are also some locally-prepared fluids, such as "Dhaka solution," which contain glucose and more potassium than Ringer's lactate, and these are better used to address potential complications of severe cholera including hypokalemia, hypoglycemia, and metabolic acidosis [60,62,63,65].

22. PREPARATION OF ORAL REHYDRATION SOLUTION (ORS)

During the preparation of ORS, the hands are first washed with soap and safe water. This is followed by the addition of 1liter (¼ gallon) of safe drinking water or boiled for at least 1 minute or chlorine product treated water into a clean container. An ORS sachet is then emptied into the water and stir with a clean utensil. This can be taken with the use of clean cup or spoon (for child) by sipping frequently. Adults and older children should continue to eat frequently. Infants and young children should continue breastfeeding frequently. Other liquids (like fruit juice) or other ingredients (like sugar or honey) must not be added to improve the taste of the ORS [52].

22.1 Oral Cholera Vaccine (OCV)

The cholera vaccine is a safe and inexpensive, highly effective, immediate protection against cholera. It offers protection for approximately three to five years (only about 67% protection) [22]. It is thus an ultimate link between emergency responses and broader preventive measures such as investments in water safety, sanitation, and hygiene services. Oral Cholera Vaccines are only an additional public health tool in complex emergencies and not replacements for usual recommended control measures such as improved water supplies, adequate sanitation, and health education [46].

Gavi, the Vaccine Alliance, is a unique public-private partnership, which finances for vaccination, reduce the cost of vaccines, and improves their delivery by supporting countries' health systems [66]. Although the use of OCV is recommended in endemic settings, with well-

defined cholera hotspots, before or during a cholera outbreak, risk assessments and the corresponding vaccination campaigns would be better options to be carried out before the onset of an outbreak. Currently, the World Health Organization (WHO) has pre-qualified three oral cholera vaccines (OCV): (Dukoral®, Shanchol™, and Euvichol-Plus®) with recommended two doses for full protection [41].

22.2 Dukoral

Dukoral, a monovalent inactivated vaccine, based on formalin and heat-killed whole cells of *V. cholerae* O1 (classical and El Tor biotypes) and recombinant B-subunit of the cholera toxin, triggers the production of antibacterial and antitoxin antibodies [67,68].

As it is mainly administered to migrants, Dukoral is composed in a buffer solution that, requires 150 ml of clean water, given in two doses to provide protection against cholera for 2 years in adults [41]. For infants (2–5 years of age), three doses, 1–6 weeks apart, are given orally, with a booster dose following after 6 months. For those ≥6 years of age, 2 oral doses, 1–6 weeks apart, with a booster dose, are given after 2 years. It has been observed that the earliest onset of protection offered by Dukoral is 7 days after the second dose, and the protection at 6 months is 85–90% [46].

23. SHANCHOL AND EUVICHOL-PLUS

The bivalent inactivated whole-cell vaccine (Shanchol), produced from *V. cholerae* sero-groups O1 (classical and El Tor biotypes) and O139, is a reformulated version of the non-WHO-qualified vaccine mORC-Vax (Vabiotech, Viet Nam) [67]. Another version of this same vaccine is Euvichol-plus, which is essentially the same vaccine produced by two different manufacturers, is the whole-cell vaccine that was prequalified by the WHO in August 2017 [69]. Euvichol or Shanchol is packaged in plastic tubes rather than the small 1.5 ml glass vials, with rubber stoppers and aluminum lids which must be removed by hand before administering [70]. This new packaging design makes the vaccine easier to open and administer and also reduces the vial storage volume by approximately 30% and weight by 50%, allowing for easier shipping, distribution, and waste management [71].

Shanchol is now easier to store and transport because, its requirements for refrigeration, cold boxes, and ice packs before administration have been minimized. Thus it can remain unrefrigerated for up to 14 days at temperatures up to 40°C prior to administration [72]. These changes in storage conditions and labelling were permitted in February 2018, by the WHO [73].

Euvichol-plus does not require a buffer solution for administration. These vaccines are administered to people over the age of one year but there must be a minimum of two weeks delay between each dose of these two vaccines. Two doses of Shanchol and Euvichol-Plus provide protection against cholera for three years, while one dose provides short term protection [41].

When it is to given to people who are ≥1 year of age; 2 oral doses, 2 weeks apart, are given and the earliest onset of protection observed is between 7–10 days after the second dose, with 65% protection for at least 5 years [46].

Shanchol and Euvichol have not been recommended for pregnant women, since research has suggests that cholera during pregnancy increases fetal distress and death [67,72,74]. However, studies carried out in Haiti with 263 women with cholera-like illness, showed that fetal death during infection with cholera was enhanced by severe maternal dehydration (risk ratio = 9.4; 95% CI: 2.5–35.3) and severe vomiting (5.1; 95% CI: 1.1–23.8) [75,76]. OCV is not contra-indicated during pregnancy [77], because the results from researches carried out in Guinea [78], Zanzibar [79], Malawi, [80] and Bangladesh [81], have shown that there is no statistically significant adverse outcomes to fetus, new born, or mother from OCV exposure.

In an efficacy trial conducted in Dhaka, Bangladesh, the vaccine protective efficacy observed with Shanchol, was 40% (95% CI: 11 to 67%) for all ages, but protection was not afforded to children 1 to less than 5 years of age (16%, 95% CI: −49 to 53%) [82,83] Similar but better results obtained in a single dose, case-cohort study in Juba, South Sudan showed that protective efficacy was 87% (95% CI: 70 to 100%), over two months among 87 suspected cholera cases (34 positive) and 858 cohort members, none of whom developed cholera [84,85].

In 2016 the CVD 103-HgR (VAXCHORA™), an oral live attenuated vaccine, was licensed by the U.S. FDA. It is well-tolerated and offers protection against cholera caused by *V. cholerae*

O1, serotype (Inaba, Ogawa) and biotype (El Tor, Classical), with a 90% vaccine efficacy that is evident 10 days after the ingestion of a single dose. The CVD 103-HgR offers rapid protection to travellers, thus the U.S. Public Health Service's Advisory Committee on Immunization Practices, recommends it for U.S. travellers to areas of ongoing cholera transmission [86].

This further buttresses the WHO recommendation to utilize OCVs reactively as an additional measure to the standard cholera epidemic response package [87]. Thus a combined comprehensive water, sanitation, and hygiene (WASH) improvement plan and OCVs deployed in identified vulnerable areas, targeting the highest risk groups first, would do the magic, especially if longer intervals are given between doses to help overcome resource/logistical limitations and enable higher coverage [15].

23.1 Herd Protection

When there is an observed reduction in the incidence resulting from reduced transmission after immunizing a portion of the target population, this is referred to as Herd immunity [88]. Herd protection reduces disease in the unimmunized and may increase protection for the vaccinated. In, a study using a geographic information systems (GIS) approach to identify cluster by level of coverage, an inverse correlation between coverage and cholera risk was observed in placebo recipients. There was a systematic reduction in cholera risk observed for each step-increase in vaccine coverage from 5.54 cases per 1,000 placebo recipients in areas with the lowest coverage (≤ 25%) to 1.93 cases per 1,000 placebo recipients among those with the highest coverage (≥ 34.01%) [73]. This indicated that increasing the level of coverage positively correlates with increases in the levels of herd protection.

23.2 Targeted Control

Ali et al. [89] stated that an estimated 1.3 billion residents in endemic areas are at risk of cholera. This therefore means that providing OCV coverage to a host of this population would be capital intensive and expensive. Policymakers would have to develop cost-effective strategies to prioritize populations so that there would be a rational basis for deploying OCVs. Five scenarios have been put forward to prioritize populations for cholera vaccination. Deen et al. [90] the regions that are challenged by natural or man-made disasters (with or without cholera transmission) and seen as requiring humanitarian emergencies concerning vaccination, are categorized as Scenario 1 and 2. Furthermore, endemic areas again with or without cholera transmission are included in scenario 3 and 4. In these areas, Vaccines would be dispatched either reactively in cases of an ongoing outbreak or pre-emptively in case of high risk due to recent cases or outbreak in a geographically adjacent area. Scenario 5 covers populations with adequate sanitation and access to water, not requiring vaccination. These resource-limited areas would require strengthened surveillance systems in addition to WASH and OCVs [73].

23.3 Stockpiling of OCVs (Gavi, the Vaccine Alliance)

Since cholera outbreaks continually reported globally, especially in countries such as Yemen, Haiti, Somalia [91], Democratic Republic of the Congo (DRC) [74] and South Sudan [73], an OCV stockpile was established and funded by Vaccine Alliance, Gavi, to help these regions in the fight against cholera. From this, any affected country that applies for and gains approval [92], is accorded some doses from the stockpile for emergencies, including reactive response to an outbreak or for preventive vaccination as part of a humanitarian crisis [93]. This duty of giving out vaccines for emergencies is handled by the International Coordinating Group (ICG), which is made up of the International Societies of the Red Cross and Red Crescent, UNICEF, WHO, and Doctors without Borders. Most especially, in the deployment for preventive vaccination to cholera hotspots, the management is done by the Global Task Force on Cholera Control, whose secretariat and that of the ICG is the WHO.

Gavi, is a public-private partnership whose duty is to save children's lives and protect people's health by promoting equality in the use of vaccines in lower resource settings. It assembles the developing countries and donor governments, the World Health Organization, UNICEF, the World Bank, the vaccine industry, technical agencies, civil society, the Bill & Melinda Gates Foundation and other private sector partners and uses innovative finance mechanisms, including co-financing by recipient countries, to secure sustainable funding and adequate supply of quality vaccines. Through the efforts made by Gavi, since 2000, about 640 million children have been the immunized and

more than 9 million preempted deaths prevention. Furthermore, to assist the Nigerian population in the cholera prevention and preparedness, free-of-cost cholera Vaccines have been sent from the stockpile to the affected areas. Thanks to the concerted efforts made by Gavi, WHO and partners, who with the NCDC and Borno State Ministry of Health have made the vaccine available [94].

In 2013, Gavi made a time-limited investment to the global cholera stockpile, and in 2016, the Gavi Board agreed to continue funding the emergency response of the stockpile for as long as it remains needed, while considering to expand OCV use to hot spots (Personal communication, Melisa Ko, Senior Programme Manager, Vaccine Implementation, Gavi). This stockpile has been in use since its inception as reported in 2017, by the Global Task Force on Cholera Control (GTFCC) [95].

Wierzba [73], reported that, from 2013 to July 2017, more than 25 million OCV doses were requested for, approximately 18 million (71%) out of this number were approved and nearly 13 million, were shipped in 46 deployments. Still in this report, it was recorded that an annual increase in the number of doses shipped was observed to be in the following order; from about 200,000 in 2013 to 1.5 million in 2014, 2.5 million in 2015, 4.6 million in 2016, and 4 million in July 2017. These OCVs were deployed to Cameroon, DRC, Ethiopia, Guinea, Haiti, Iraq, Malawi, Mozambique, Nepal, Niger, Somalia, South Sudan, Sudan, Tanzania, and Zambia, with Haiti receiving largest number of doses (2,517,815), followed by Somalia (2,101,400), and South Sudan (1,969,660).

The GTFCC is using a rigorous system for monitoring and evaluating OCV use, studying the effectiveness, coverage, acceptability, feasibility, safety, costs, and cost-effectiveness, in diverse populations residing in different geographic settings [96]. They are suggesting the application of the Case-control, cohort, GIS, study systems [97] and use of case-negative designs, [98]. The test-negative designs have been employed in several observational studies and randomized controlled OCV trials and found to be a useful tool in epidemiological studies [99].

23.4 Antibiotic Therapy

Since most cholera deaths usually occur due to the prolonged loss of fluids from the body, the administration of effective antibiotics treatment can reduce the duration of diarrhea, the volume of stool losses, and lessen the duration of *V. cholerae* shed in the stool. Cholera disease is usually accompanied by vomiting, therefore, oral antibiotic treatment will only be recommended after initial rehydration and when the vomiting has stopped [59]. The antibiotic options recommended for cholera include macrolides, fluoroquinolones, and tetracyclines, based on availability and local resistance patterns [60]. For patients with severe volume depletion and culture confirmed tetracycline-susceptible *V. cholerae*, a single high dose of doxycycline (300 mg) can give the same results as tetracycline 500 mg, every six hours given as a two-day course with respect to stool output, duration of diarrhea, vomiting, and requirement for oral rehydration solution. The use of tetracycline and doxycycline is limited to outbreak settings because resistance is common. However, fluoroquinolones and macrolides, normally serve as alternatives, although resistance to fluoroquinolones is also growing in endemic areas. Ciprofloxacin 1000 mg single dose has been reported to be more effective against both strains of *V. cholerae* than doxycycline 300 mg single dose [60,100,101,102,103].

Macrolides (erythromycin 12.5 mg/kg, every six hours for three days and azithromycin 20 mg/kg single dose) have also showed similar clinical and bacteriological effects against infection with the two strains of *V. cholera* in adults and children. Furthermore, treatment with azithromycin is accompanied by less vomiting. Resistance to trimethoprim-sulfamethoxazole and furazolidone has been recorded against most *V. cholerae* O139 and O1 El Tor strains [60,55].

24. NUTRITION

In addition to a good surveillance system, WASH, OCV, ORS and appropriate antibiotic treatment, supplementation with adequate nutrition and vitamins in patients with cholera, is of utmost importance [9]. This helps to arrest malnutrition and facilitate recovery of normal gastrointestinal function. The resumption to solid food and breastfeeding of infants as soon as possible after the initial fluid deficit of cholera is corrected, should be encouraged in conjunction with oral rehydration solution. However, the supplementation of the diet for children with acute diarrhea, with zinc and vitamin A, reduces the duration and volume of stool [41,64,104].

25. CONCLUSION

The fact that Cholera remains a problem in developing countries and a risk for travellers, despite improvements in water quality, sanitation, and hygiene, as well as in the clinical treatment of cholera, means that more, still has to be done especially in endemic areas of the world. Good Surveillance systems and Oral vaccines containing inactivated *V. cholerae,* to help augment WASH, ORS are now made available in some of these countries. For example, in 2016 the CVD 103-HgR (VAXCHORA™), an oral live attenuated vaccine, was licensed by the U.S. FDA. It is well-tolerated and protects against cholera caused by *V. cholerae* O1, serotype (Inaba, Ogawa) and biotype (El Tor, Classical) with a 90% vaccine efficacy that is evident, 10 days after the ingestion of a single dose. It offers rapid protection to travellers. Thus a combined comprehensive water, sanitation, and hygiene (WaSH) improvement plan and OCVs deployed in identified vulnerable areas, targeting the highest risk groups first, would do the magic, especially if longer intervals are given between doses to help overcome resource/logistical limitations and enable higher coverage.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Tarh JE. An overview of cholera epidemiology: A focus on Africa; with a keen interest on Nigeria. IJTDH. 2019;40(3):1-17.
   DOI: 10.9734/IJTDH/2019/v40i330229
2. Islam MT, Khan AI, Sayeed MA, Amin J, Islam K, Alam N, et al. Field evaluation of a locally produced rapid diagnostic test for early detection of cholera in Bangladesh. PLoS Negl Trop Dis. 2019;13(1): e0007124.
   Available:https://doi.org/10.1371/journal.pntd.0007124
3. UNICEF Bulletin: Cholera and AWD outbreaks in Eastern and Southern Africa. Regional Update for 2019 - as of 2 May 2019.
4. UNICEF. Cholera epidemiology and response factsheet Nigeria; 2018.
   Available:https://www.unicef.org/cholera/files/UNICEF-Factsheet-Nigeria-EN-FINAL.pdf
5. Handa S. Cholera; 2018.
   Available:https://emedicine.medscape.com/article/962643-overview
6. Tarh JE, Mboto CI, Asikong BEE, Iroegbu CU. *Vibrio cholerae* incursion in Africa, the Journey So Far J Sci Res Rep. 2019; 25(3-4):1-12.
   DOI: 10.9734/JSRR/2019/v25i3-430181
7. Tarh JE. Epidemiological distribution of different *Vibrio cholerae* strains causing cholera disease in endemic countries: A review JAMMR. 2019;31(5):1-15.
   DOI: 10.9734/JAMMR/2019/v31i530298
8. Who.int. Diarrhoeal disease; 2017. [Online]
   Available:https://www.who.int/news-room/fact-sheets/detail/diarrhoeal-disease
   [Accessed 12 Aug. 2019]
9. Dadonaite B. More than half a million children die from diarrhea each year. How do we prevent this? Our World in Data; 2019.
10. Spiegel P, Ratnayake R, Hellman N, Mija Ververs, Ngwa M, Wise PH, et al. Responding to epidemics in large-scale humanitarian crises: A case study of the cholera response in Yemen, 2016–2018. BMJ Global Health. 2019;4:e001709.
    DOI: 10.1136/ bmjgh-2019-001709
11. WHO/WHE/IHM/2019 Sixth Annual Meeting of the global task force on cholera control. 3 - 4 June, 2019 – Les Pensières Center for Global Health 1-36.
    Available:WWW.WHO.INT/CHOLERA
12. Somboonwit C, Menezes LJ, Holt DA, Sinnott JT, Shapshak P. Current views and challenges on clinical cholera Bioinform. 2017;13(12):405-409.
    Available: www.bioinformation.net

13. Owoeye D, Adebayo O. Control and prevention of cholera transmission in low resource clinical setting. Nig J Med. 2018;27:1.
Available:https://www.ajol.info/index.php/njm/article/view/176392
14. Premium Times. Nigeria: Cholera cases drop 60% globally, as Nigeria Records Significant Progress – WHO; 2019.
Available:https://allafrica.com/stories/201912200013.html
15. Chatterjee P, Kanungo S, Dutta S. Challenges for programmatic implementation of killed whole cell oral cholera vaccines for prevention and control of cholera: A meta-opinion. Expt Opin Biol Ther. 2018;18(9):983-988.
DOI: 10.1080/14712598.2018.1512578
Epub 2018 Aug 21
16. Clemens JD, Nair GB, Ahmed T, Qadri F, Holmgren J. The effectiveness of one or two doses of either Shanchol (Shantha Biotechnics; India) or ORC-Vax (Vabiotech; Vietnam) OCVs showed a combined vaccine effectiveness of 75% (95% CI, 61-84). Lancet. 2017;390(10101):1539-1549.
DOI: 10.1016/S0140-6736(17)30559-7
Epub 2017 Mar 13.Cholera
17. One Team against Cholera – Regional coalition for water and sanitation to eliminate cholera in Hispaniola.htm Proudly powered by Word Press.
18. Available:https://population.un.org/wpp/DataQuery/ UN4 projection
19. National WASH Cluster. WASH strategic framework for cholera risk reduction and response during the rainy season in N-E Nigeria; 2017.
20. Bencivenga J. Is geospatial data the key to leaving no one behind? eHealth Africa; 2019.
21. Sim C. Control and intervention of cholera outbreaks in refugee camps. Glob Soc J. 2013;(1):65-79.
22. Republic of Uganda, National integrated comprehensive cholera prevention and control plan, Fiscal Year (2017/18-2021/22). 2017;1-76.
23. Ahmed MU, Baquilod M, Deola C, Dong TN, Duc AD, Grasso C, et al. Cholera prevention and control in Asian countries. 2017;1-10.
24. Abdulhadi SK, Tukur AD, Ahmed BOK, Bawa, E, Ajagbe JM, Ezekiel DB, Abdulhakeen AY, Muhammad NB, Rabiu M. Contemporary understanding of *V. cholerae* and cholera outbreaks. J Infect Dis Medical Microbiol. 2018;2(3):1-6.
25. Zanzibar comprehensive cholera elimination plan (ZACCEP); 2018-2027.
26. WHO/UNICEF. The Republic Of Uganda. Prevention and control Of Cholera. Operational guidelines for the national and district health workers & planners control of diarrhoeal diseases (cdd) section community health department, Ministry of Health WHO / UNICEF for Every Child; 2017.
27. Adeyemo A, Kombian H. Fighting cholera with the power of geospatial mapping disease surveillance, gis & data analytics, our solutions ehealth Africa (eHA) Geographic Information Systems (GIS); 2019.
28. Geographic Information Systems — eHealth Africa - Building stronger health systems in Africa.
29. Bencivenga J. Opinion: Is geospatial data the key to leaving no one behind? Global Views Turning the Tide // 31 October 2019 Devex.htm
30. Aether by eHealth Africa our Solutions; 2019.
31. Shehu A, Awa-Agwu E. Supporting access to immunization through supplementary immunization activities. GIS & Data Analytics, Health Delivery Systems, Public Health Emergency Blog— eHealth Africa - Building stronger health systems in Africa; 2019.
32. WHO. Integrated epidemiological surveillance of diseases: Regional strategy for communicable diseases (resolution AFR/RC48/R2). Harare, Zimbabwe. Forty-eighth Session of the WHO Regional Committee for Africa; 1998.
33. Fall IS, Rajatonirina S, Yahaya AA, Zabulon Y, Fall ISP, Rajatonirina S, Yahaya AA, et al Integrated Disease Surveillance and Response (IDSR) strategy: current status, challenges and perspectives for the future in Africa BMJ Global Health. 2019;4:e001427.
DOI:10.1136/bmjgh-2019-001427.http://dx.doi.org/10.1136/bmjgh-2019-001427
34. Mandja B-AM, Bompangue D, Handschumacher P, Gonzalez4 J-P, Salem G, Muyembe J-J, Mauny F. The score of integrated disease surveillance and response adequacy (SIA): A pragmatic score for comparing weekly reported

diseases based on a systematic review BMC Public Health. 2019;19:624: 1-14. Available:https://doi.org/10.1186/s12889-019-6954-3

35. Gleason BL, Kamara A, Clemens N, Kargbo D. Establishment of an electronic integrated disease surveillance and response system in Sierra Leone. Int J Infect dis. 2019;79(1):111. Open Access. DOI:https://doi.org/10.1016/j.ijid.2018.11.275
36. Available:https://www.ehealthafrica.org/eidsr Cholera prevention and control/eIDSR — eHealth Africa - Building stronger health systems in Africa.htm
37. Ngaujah S, Clemens N. Going digital improves Disease Surveillance in Sierra Leone. Disease Surveillance; 2019. Our Solutions eHealth Africa.
38. Cholera prevention and control/Health Delivery Systems — eHealth Africa - Building stronger health systems in Africa.htm.
39. Falodun T, Awa-Agwu E. Modelling disease surveillance systems that work in chad and Niger Disease Surveillance, Polio Eradication — eHealth Africa - Building stronger health systems in Africa.htm; 2019.
40. Mufunda J. The country representative WHO Lusaka; 2016. Department For International Development UKaid.
41. World Health Organization (WHO). Cholera; 2019. Available:https://www.who.int/news-room/fact-sheets/detail/Cholera
42. Nigeria Cholera Response Factsheet – Report Solidarites International; 2020.
43. U.S. Department of Health and Human Services Centers for Disease Control and Prevention. Available:http://www.cdc.gov/haiticholera
44. Global Task Force on Cholera Control. Ending cholera. A global roadmap to 2030. Geneva, Switzerland: WHO; 2017.
45. Chipare T. Strategies to cope with the impact of cholera on Zimbabwe from 2008-2009: A case study of Budiriro High Density Suburb, City of Harare. 2010;1-140.
46. Jahan S. Cholera-epidemiology, prevention and control; 2016. DOI: 10.5772/63358
47. Sharifi-Mood, Metanat B, Diagnosis M. Clinical management, prevention and control of cholera; A review study. IJInfect. 2014;1(1):e18303. DOI: 10.17795/iji-18303
48. WHO. Cholera: Prevention and control of cholera outbreaks: WHO policy and recommendations; 2018.
49. Yennan S. Improving surveillance and laboratory detection towards the 'ending cholera' strategy. Nigeria Centre for Disease Control, A healthier and safer Nigeria through the prevention and control of diseases of public health importance. 08/11/2018.
50. Ayenigbara IO, Ayenigbara GO, Adeleke RO. Contemporary Nigerian public health problem: Prevention and surveillance are key to combating cholera. GMS Hyg Infect Control. 2019;14:Doc16. (Published online 2019 Oct 31) DOI: 10.3205/dgkh000331
51. Stoppler, MS. Cholera Center; 2018. Available:http://www.intechopen.com/books/significance-prevention-and-control-of-food-related-diseases/cholera-epidemiology-prevention-and-control
52. Reid K. What is cholera? Facts, FAQs and how to help. World vision. From the Field. Updated on: April 15; 2019.
53. Available:http://www.cdc.gov/cholera/materials.htm U.S. Department of Health and Human Services CDC
54. World Health Organization / Emerging and other Communicable Diseases, Surveillance and Control. WHO guidance on formulation of national policy on the control of cholera. WHO/CDD/SER/92.16 REV.1; 1992. [Accessed 2018 Jun 14] Available:https://www.who.int/topics/cholera/publications/WHO_CDD_SER_92_16/en/
55. Centers for Disease Control and Prevention, National Center for Emerging and Zoonotic Infectious Diseases (NCEZID), Division of Foodborne, Waterborne, and Environmental Diseases (DFWED) Page last reviewed: July 24; 2017.
56. Integrated Disease Surveillance and Response Technical Guidelines, Booklet One: Introduction Section. Brazzaville: WHO Regional Office for Africa; 2019. Licence: CC BY-NC-SA 3.0 IGO.
57. WHO Cholera. WHO position paper on Oral Rehydration Salts to reduce mortality from cholera; 2020. Available:https://www.who.int/cholera/technical/en/
58. Kühn J, Finger F, Bertuzzo E, Borgeaud S, Gatto M, Rinaldo A, et al. Glucosebut not

rice-based oral rehydration therapy enhances the production of virulence determinants in the human pathogen *V. cholerae*. PLoS Negl Trop Dis. 2014;8(12): e3347.
DOI: 10.1371/journal.pntd.0003347

59. NaTHNaC Factsheets Cholera: 03 Oct, 2019. TravelHealthPro Cholera epidemiology file/NaTHNaC - Cholera.htm.
60. Larocque R, Harris JB. Cholera: Clinical features, diagnosis, treatment and prevention. Literature Review Current Through; 2019.
Available:https://www.uptodate.com/contents/cholera-clinical-features-diagnosis-treatment-and-prevention#H609426356
61. WHO. The treatment of diarrhoea, a manual for physicians and other senior health workers. 4th Revision. WHO/FCH/CAH/05.1. Geneva: World Health Organization; 2005.
Available:http://whqlibdoc.who.int/publications/2005/9241593180.pdf
(Accessed on January 08, 2010)
62. Available:https://www.unicef.org/supply/files/Oral_Rehydration_Salts(ORS)_pdf
[Accessed 17/10/2017]
63. Available:http://whqlibdoc.who.int/publications/2005/921593180.pdf
[Accessed 17/10/2017]
64. Pietroni MAC. Case management of cholera Vaccine 38 2020; A105–A109.
Available:www.elsevier.com/locate/vaccine
65. Available:https://rehydrate.org/solutions/homemade.htm
[Accessed 15.09.2019]
66. Zaidi A. How we can defeat cholera for good World Economic Forum in collaboration with Project Syndicate; 2019.
67. Moore S. Dynamics of Cholera Epidemics in Haiti and Africa. 2016;1-178.
68. Harris JB. Cholera: Immunity and prospects in vaccine development. The J Infec Dis. 2018;218(3):S141–S146.
Available:https://doi.org/10.1093/infdis/jiy414
69. WHO. WHO prequalified vaccines. Euvichol-Plus; 2018. [Google Scholar]
[Accessed 2018 Mar 26]
Available:https://extranet.who.int/gavi/PQ_Web/PreviewVaccine.aspx?nav=0&ID=336
70. Kar SK, Sah B, Patnaik B, Kim YH, Kerketta AS, Shin S, et al. Mass vaccination with a new, less expensive oral cholera vaccine using public health infrastructure in India: the Odisha model. PLoS Neglected Tropical Diseases. 2014;8:e2629.
DOI: 10.1371/journal.pntd.0002629
71. International Vaccine Institute. Euvichol-Plus®, 'the world's first plastic vial oral cholera vaccine,' ready for global use; 2018.
[Accessed 2018 Mar 28]
Available:http://www.ivi.int/?mod=document&uid=956&page_id=12463
72. WHO. WHO prequalified vaccines. Shanchol. [Google Scholar]
[Accessed 2018 Mar 26]
Available:https://extranet.who.int/gavi/PQ_Web/PreviewVaccine.aspx?nav=0&ID=249
73. Wierzba TF. Review oral cholera vaccines and their impact on the global burden of disease. JHum Vacc Immunother. 2019;15(6). Vaccines for Enteric Diseases (ENTERIC SI)
74. WHO. Cholera – Kinshasa, Democratic Republic of the Congo; 2018.
[Accessed 2018 Apr 13]
Available:http://wwwwhoint/csr/don/02-march-2018-cholera-drc/en/
75. Ciglenecki I, Bichet M, Tena J, Mondesir E, Bastard M, Tran NT, et al. Cholera in pregnancy: Outcomes from a specialized cholera treatment unit for pregnant women in Leogane, Haiti. PLoS Negl Trop Dis. 2013;7:e2368.
DOI: 10.1371/journal.pntd.0002368
76. Schillberg E, Ariti C, Bryson L, Delva-Senat R, Price D, Grand Pierre R, Lenglet A. Factors related to fetal death in pregnant women with cholera, Haiti, 2011-2014. Emerg Infect Dis. 2016;22:124–127.
DOI: 10.3201/eid2201.151078
77. Moro PL, Sukumaran L. Cholera vaccination: Pregnant women excluded no more. Lancet Infect Dis. 2017;17:469–470.
DOI: 10.1016/S1473-3099(17)30055-5
78. Grout L, Martinez-Pino I, Ciglenecki I, Keita S, Diallo AA, Traore B, et al. Pregnancy outcomes after a mass vaccination campaign with an oral cholera vaccine in guinea: A retrospective cohort study. PLoS Negl Trop Dis. 2015;9: e0004274.
DOI: 10.1371/journal.pntd.0004274
79. Hashim R, Khatib AM, Enwere G, Park JK, Reyburn R, Ali M, et al. Safety of the recombinant cholera toxin B subunit, killed whole-cell (rBS-WC) oral cholera vaccine in pregnancy. PLoS Negl Trop Dis. 2012;6:e1743.
DOI: 10.1371/journal.pntd.0001743

80. Ali M, Nelson A, Luquero FJ, Azman AS, Debes AK, M'Bang'ombe MM, et al. Safety of a killed oral cholera vaccine (Shanchol) in pregnant women in Malawi: An observational cohort study. Lancet Infect Dis. 2017;17:538–544.
DOI: 10.1016/S1473-3099(16)30523-0
81. Khan AI, Ali M, Chowdhury F, Saha A, Khan IA, Khan A, et al. Safety of the oral cholera vaccine in pregnancy: retrospective findings from a subgroup following mass vaccination campaign in Dhaka, Bangladesh. Vaccine. 2017;35: 1538–1543.
DOI: 10.1016/j.vaccine.2017.01.080
82. Qadri F, Wierzba TF, Ali M, Chowdhury F, Khan AI, Saha A. Efficacy of a single-dose, inactivated oral cholera vaccine in Bangladesh. N Engl J Med. 2016;374: 1723–1732.
DOI: 10.1056/NEJMoa1510330
83. Qadri F, Ali M, Lynch J, Chowdhury F, Khan AI, Wierzba TF, et al. Efficacy of a single-dose regimen of inactivated whole-cell oral cholera vaccine: Results from 2 years of follow-up of a randomised trial. Lancet Infect Dis; 2018.
DOI: 10.1016/S1473-3099(18)30108-7
84. Azman AS, Luquero FJ, Ciglenecki I, Grais RF, Sack DA, Lessler J. Correction: The impact of a one-dose versus two-dose oral cholera vaccine regimen in outbreak settings: A modeling study. PLoS Med. 2016;13:e1001989.
DOI: 10.1371/journal.pmed.1001989
85. Azman AS, Parker LA, Rumunu J, Tadesse F, Grandesso F, Deng LL, et al. Effectiveness of one dose of oral cholera vaccine in response to an outbreak: A case-cohort study. Lancet Glob Health. 2016;4:e856–e63.
DOI: 10.1016/S2214-109X(16)30211-X
86. Levine MM, Chen WH, Kaper JB, Lock M, Danzig L, Gurwith M. Exp Rev Vaccines. 2017;16(3):197-213.
DOI: 10.1080/14760584.2017.1291348
PaxVax CVD 103-HgR single-dose live oral cholera vaccine
87. Schwerdtle P, Onekon CK, Recoche K. A quantitative systematic review and meta-analysis of the effectiveness of oral cholera vaccine as a reactive measure in cholera outbreaks. Prehosp Disaster Med. 2018;33(1):2-6.
88. Smith PG. Concepts of herd protection. Procedia in Vaccinology. 2010;2:134–139.
[Crossref], [Google Scholar]
DOI: 10.1016/j.provac.2010.07.005
89. Ali M, Nelson AR, Lopez AL, Sack DA. Updated global burden of cholera in endemic countries. PLoS Negl Trop Dis. 2015;9:e0003832.
DOI: 10.1371/journal.pntd.0003832
90. Deen J, Von Seidlein L, Luquero FJ, Troeger C, Reyburn R, Lopez AL. The scenario approach for countries considering the addition of oral cholera vaccination in cholera preparedness and control plans. Lancet Infect Dis. 2016;16: 125–129.
DOI: 10.1016/S1473-3099(15)00298-4
91. UNICEF. Cholera vaccination campaign begins in Somalia; 2017. [Google Scholar] [Accessed 2018 Mar 28]
Available:https://www.unicef.org/somalia/media_19616.html
92. WHO. Guidance on how to access the Oral Cholera Vaccine (OCV) from the ICG emergency stockpile.
[Accessed 2018 Apr 16]
Available:https://www.unicef.org/cholera/files/Guidance_accessing_OCV_stockpile.pdf
93. World Health Organization. Cholera country profile : Nigeria. Global Task Force on Cholera Control; 2012.
94. WHO Africa. Cholera vaccination campaign begins in north-eastern Nigeria; 2017.
95. Wkly Epidemiol Rec. Deployments from the oral cholera vaccine stockpile. 2013-2017;92:437–442. [PubMed], [Google Scholar]
96. Platts-Mills JA, Babji S, Bodhidatta L, Gratz J, Haque R, Havt A, McCormick BJ, McGrath M, Olortegui MP, Samie A, et al. Pathogen-specific burdens of community diarrhoea in developing countries: A multisite birth cohort study (MAL-ED). Lancet Glob Health. 2015;3:e564–75.
[Crossref], [PubMed], [Web of Science ®], [Google Scholar]
DOI: 10.1016/S2214-109X(15)00151-5
97. Deen J, Ali M, Sack D. Methods to assess the impact of mass oral cholera vaccination campaigns under real field conditions. PLoS One. 2014;9:e88139.
DOI: 10.1371/journal.pone.0088139
98. Wierzba TF, Kar SK, Mogasale VV, Kerketta AS, You YA, Baral P, et al. Effectiveness of an oral cholera vaccine campaign to prevent clinically-significant

cholera in Odisha State, India: Vaccine. 2015;33:2463–2469. [Crossref]

99. Ali M, You YA, Sur D, Kanungo S, Kim DR, Deen J, et al. Validity of the estimates of oral cholera vaccine effectiveness derived from the test-negative design. Vaccine. 2016;34:479–485. [Crossref], [PubMed], [Web of Science ®], [Google Scholar] DOI: 10.1016/j.vaccine.2015.12.004
100. Centers for Disease Control and Prevention, National Center for Emerging and Zoonotic Infectious Diseases (NCEZID), Division of Foodborne, Waterborne, and Environmental Diseases (DFWED) Page last reviewed: January 20; 2015
101. Pietroni MAC. Cholera, method of in conn's current therapy, Bope ET, Kellerman RD, Editors. Philadelphia: Elsevier. 2017;497–500.
102. Harris JB, Pietroni MAC. Approach to the child with acute diarrhea in resource limited countries. In: Calderwood SB, Bloom A, Editors. UpToDate. Waltham, MA: UpToDate; 2017.
103. LaRocque R, Pietroni MAC. Approach to the adult with acute diarrhea in resource limited countries. In: Calderwood SB, Bloom A, Editors. UpToDate. Waltham, MA: UpToDate; 2017.
104. Mayo Clinic. Cholera patient care & health information diseases & conditions; 2020. Available:https://www.mayoclinic.org/diseases-conditions/cholera/diagnosis-treatment/drc-20355293

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