Cholera, Climate change and AMR crisis in Africa

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Drugs for Neglected Diseases initiative

Kenya Medical Research Institute

Your article “Why cholera continues to threaten many African countries” has been published on The Conversation.

Here's the link:
https://theconversation.com/why-cholera-continues-to-threaten-many-african-countries-197799

poor sanitation and limited access to clean water.
But it has also been found in seemingly clean places, including affluent neighbourhoods, hotels and restaurants with poor hygiene practices such as handling food with dirty hands and using contaminated water to wash utensils and prepare food.
Cholera outbreaks in Africa have affected 18 countries over the last two years.
In southern and eastern Africa, more than 6,000 people have died and nearly 350,000 cases have been reported since a series of outbreaks began in late 2021.

Samuel Kariuki, a microbiologist and director of the Drugs for Neglected Diseases Initiative (Eastern Africa) and former director of the Kenya Medical Research Institute, explains how the disease spreads, the symptoms, how to protect yourself, and how it can be treated.

https://theconversation.com/cholera-can-kill-you-within-hours-if-left-untreated-how-to-recognise-the-symptoms-and-protect-yourself-231551

• Cholera in Kenya: Climatic cycles leading to frequent cholera outbreaks

- **Previous Major outbreaks in Kenya:** 1981-83, 1997-99, and 2008-2010.
- **Largest outbreak:** 1997 and 1998; more than 50,000 infected, case fatality rates 3.8 - 4.7%.

These periods coincided with El Niño and La Niña climatic cycles.

- **2021-2022:** Flooding in parts of city, followed by prolonged drought and water shortages
- Continuing drought has worsened the situation, access to clean water a huge challenge.
- **As of January 2023,** Kenya had recorded **4,713 cases of cholera with 72 deaths** accounting for 1.73%.
- So far the **outbreak has spread to 14 counties across the country**.
- **The poor WaSH infrastructure** (and water shortages) in urban and informal settlements (sewer disposal, open drains) also driving the spread of cholera.
- **We see more outbreaks even in the dry season!**

Cholera Situation in the Rest of Africa

- As of Dec 2023, 24 countries reported cholera cases. Associated mortality, particular concern due to higher case-fatality ratios (CFR) than in previous years.
- Average cholera CFR reported globally in 2021 was 1.9% (2.9% in Africa), a significant increase above the accepted targeted rate (<1%), highest in a decade.

Figure-1: Global situation of active epidemics of cholera and acute watery diarrhea as of 20 March 2023

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of WHO concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Health Organization
Map Production: WHO Health Emergencies Programme
Map Date: 20 March 2023

World Health Organization

Mapping Hotspots and transmission pathways for cholera

Mukuru kwa Njenga and Mukuru Reuben are among the many villages in the Mukuru

Catchment population for Mukuru

Description	Population
Total catchment population	150,000
Children under 1yr(12months)	22,000
Children under 5 yrs (60months)	30,000
Children under 15 yrs	37,000
Adults (24-59yrs)	50,000
Elderly (over 60yrs)	11,000

Emergence of MDR and ESBL producing *V. cholerae*

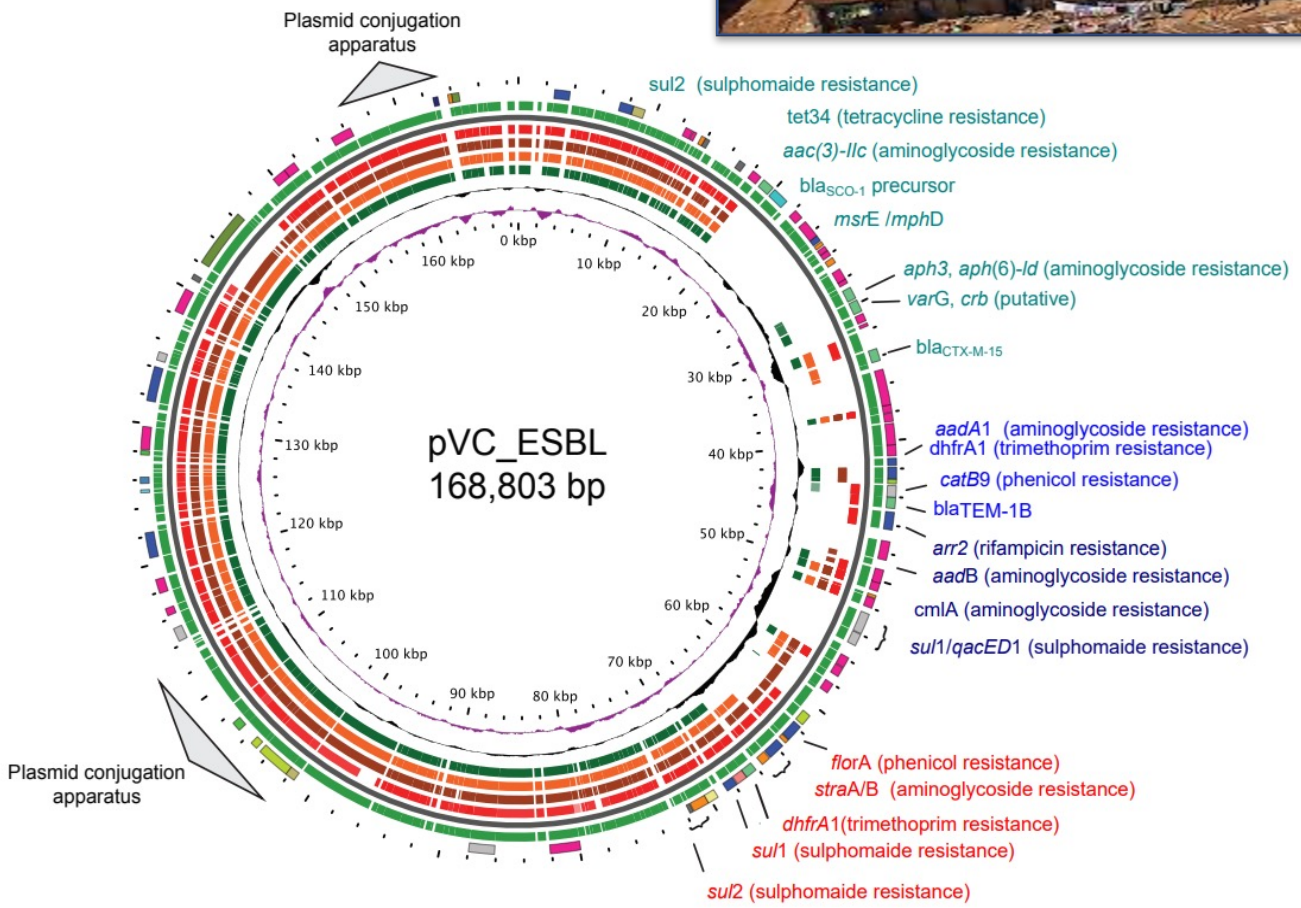
- The **first ESBL strains** were recovered from Daadab refugee camps close to the Somali border in early **2012**.
- Such strains later **emerged in urban slums** including Kibera and Mukuru.
- The **first major outbreak of cholera with the MDR phenotype** started in Tana river delta 250 km East of Nairobi in **2015**.
- Since then ESBL producing *Vibrio cholerae* have persisted in disease outbreaks in Kenya.
- Phylogenetic analysis of our strains showed similarity with strains from the Yemeni major epidemic from 2010.

MDR *V. cholerae* : WGS shows 3 main regions on the pVC_ESBL

- SXT R319 carrying the *flo*R-*dhfr*A1-*str*A-*Str*B-*sul*2 genes.

- class 1 integron carrying *aadB-arr2-bla*$_{TEM1B}$-*cmlA-bla*$_{OXA-10}$-*arr-2-aadA1* cassettes and with *sul1* and a truncated *qacEΔ*1 gene at the 3' conserved end.

- Resistance genes inserted into the plasmid backbone encoding resistance to *bla*$_{CTX-M-15)}$, *aac(3)-IIc* that confer resistance to streptomycin, kanamycin and tobramycin and a putative gene for tunicamycin resistance



Efforts in mapping environmental contamination, hotspots and interventions

Household Surveys

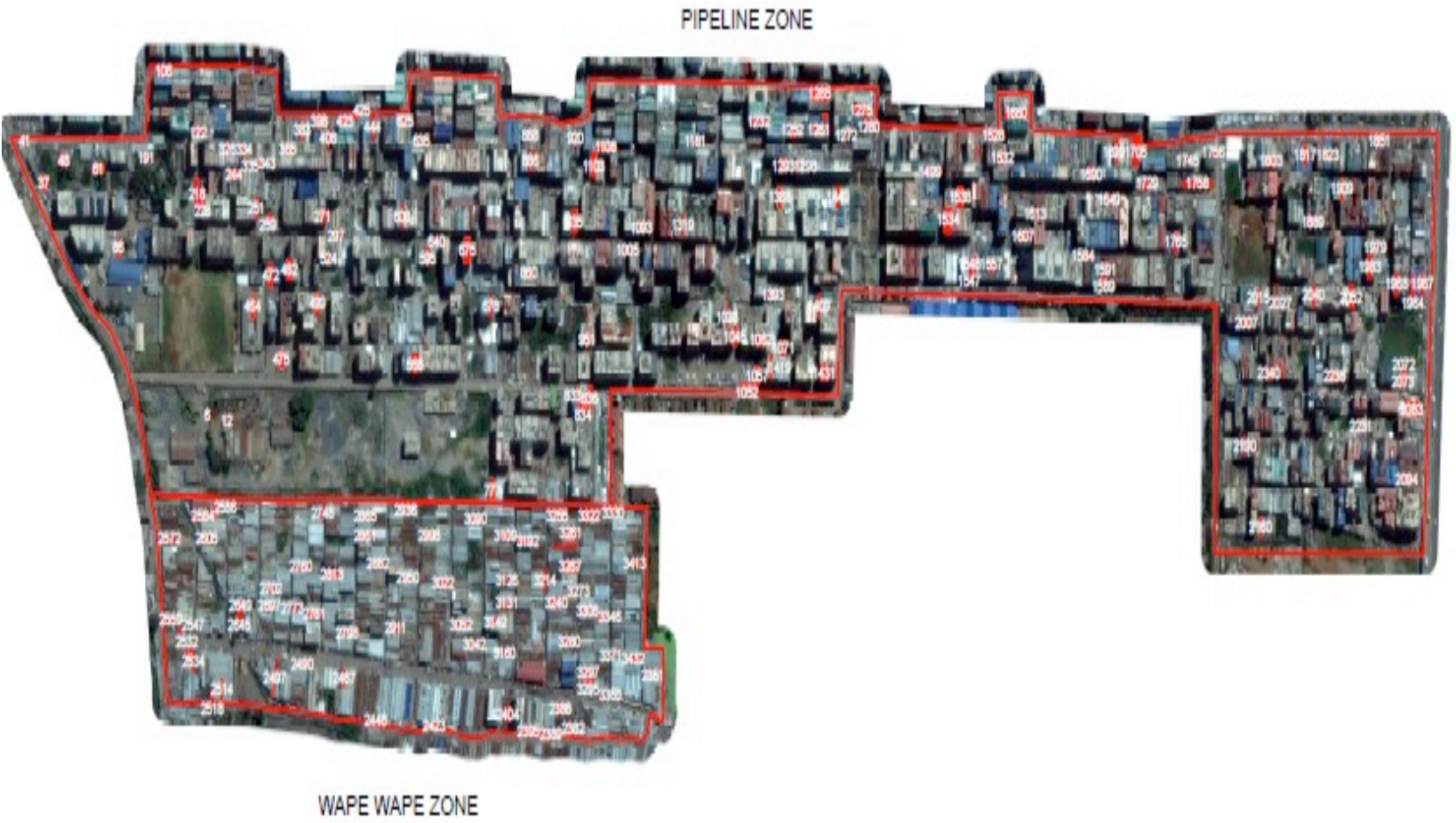
Mukuru Kwa Reuben

Randomized Households/Blocks for both Wet and Dry seasons

(Kwa Reuben)

Gatope	174
Mombasa	120
FTC	106
Total	400

Mukuru Kwa Njenga



Randomized Households/Blocks for both Wet and Dry seasons

(Kwa Njenga)

Pipeline	168
Wapewape	232
Total	400

School surveys

Neighborhood	School Sampled	School Category	Group	No. of Participants Dry season	No. of Participants Wet season
Mukuru Kwa Reuben	AEF Reuben Primary School	Public School	Girls	20	20
			Boys	20	20
	Rejoice Education Centre	Private School	Girls	20	20
			Boys	20	20
Mukuru Kwa Njenga	Kwa Njenga Primary School	Public School	Girls	20	20
			Boys	20	20
	Jobenpha Primary School	Private School	Girls	20	20
			Boys	20	20

Community Survey

	Groups	No. of Participant DRY	No. of Participant WET
Mukuru Kwa Njenga	Women Group1	17	20
	Women Group2	17	20
	Men Group1	20	20
	Men Group2	16	15
Mukuru Kwa Reuben	Women Group1	15	20
	Women Group2	16	20
	Men Group1	17	17
	Men Group2	20	20
TOTAL		**138**	**152**

Environmental Sampling

Based on the transect walk, 9 pathways were identified as the most probable routes of exposure to *V. cholerae*

Drinking water

- municipal,
- borehole
- Vendors
- stored drinking

Street food

french fries

githeri

mandazi

Shaved ice

Raw produce

tomatoes

coriander

Flood Water

Surface Water

Open Drain

Soil

Public Latrine swab

Samples analysed per neighbourhood and *V. cholerae* positivity by qPCR per sample type

	Percent of Positive (Number of Positive/Number of Samples)		
Sample types	**Mukuru Kwa Reuben**	**Mukuru Kwa Njenga**	**Total**
Drinking water	6.5% (7/107)	4.0% (6/150)	5.1% (13/257)
Flood water	60.0% (9/15)	80.0% (12/15)	70.0% (21/30)
Open drain	73.3% (33/45)	80.4% (37/46)	77.0% (70/91)
Public latrine	20.0% (3/15)	26.7% (4/15)	23.3% (7/30)
Raw produce	13.3% (2/15)	20.0% (3/15)	16.7% (5/30)
Shaved ice	0% (0/14)	0% (0/15)	0% (0/29)
Soil	6.7% (1/15)	26.7% (4/15)	16.7% (5/30)
Street food	7.1% (10/140)	3.6% (5/137)	5.4% (15/277)
Surface water	93.3% (14/15)	100% (14/14)	96.6% (28/29)
Total	20.7% (79/381)	20.1% (85/422)	20.4% (164/803)

- No culture positive for *V.c*
- *V. cholerae* positivity was highest in surface water (96.6 %)with Flood water and Open drain also showing over 70% positivity.
- Of importance includes drinking water, Street foods and Raw produce, which are ingested and *V. c* was detected.

V. Cholera Quantification(Estimated number of *V. c* copies per sample)

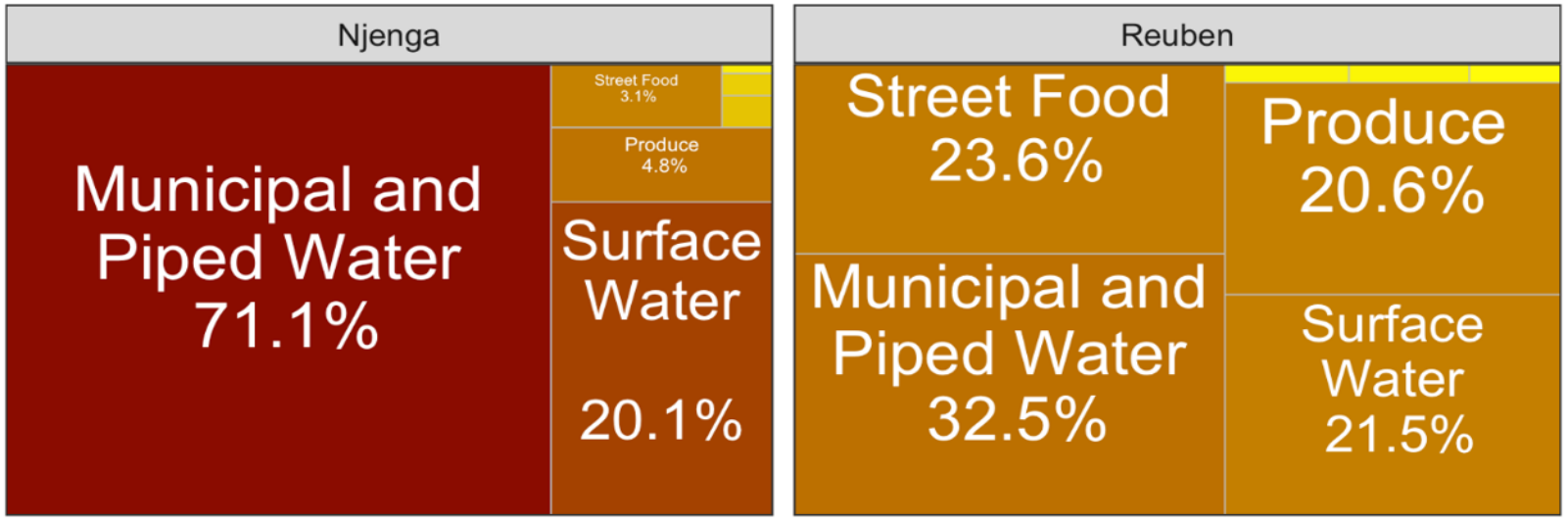
	Mean *V. Cholerae* Concentration		
Sample types	Mukuru Kwa Reuben	Mukuru Kwa Njenga	Total
Drinking water	19.4 (7.0–40.0)	32.8 (4.0–107.0)	25.6 (4.0–107.0)
Flood water	3731.5 (43.0–27320.0)	1558.9 (25.0–7357.0)	2490.0 (25.0–27320.0)
Open drain	4244.4 (19.0–48730.0)	2777.4 (45.0–27665.0)	3469.0 (19.0–48730.0)
Public latrine	6618.5 (4740.0–9100.4)	4811.2 (3049.7–7132.5)	5585.7 (3049.7–9100.4)
Raw produce	127.1 (69.8–184.4)	1243.1 (35.2–3553.1)	796.7 (35.2–3553.1)
Shaved ice			
Soil	309.4 (309.4–309.4)	1793.5 (79.6–5980.0)	1496.7 (79.6–5980.0)
Street food	587.6 (125.9–1948.5)	489.0 (165.2–1021.5)	554.7 (125.9–1948.5)
Surface water	971.3 (38.0–3780.0)	4768.6 (150.0–19975.0)	2867.0 (38.0–19975.0)

- *V. c* quantification was done by generating a standard curve using commercial ***V. c*** DNA standard, and the number of *V. c* DNA copies were estimated per ml or grams of liquid and solid samples, respectively.
- All samples with a C.T value of ≤36 were quantified.

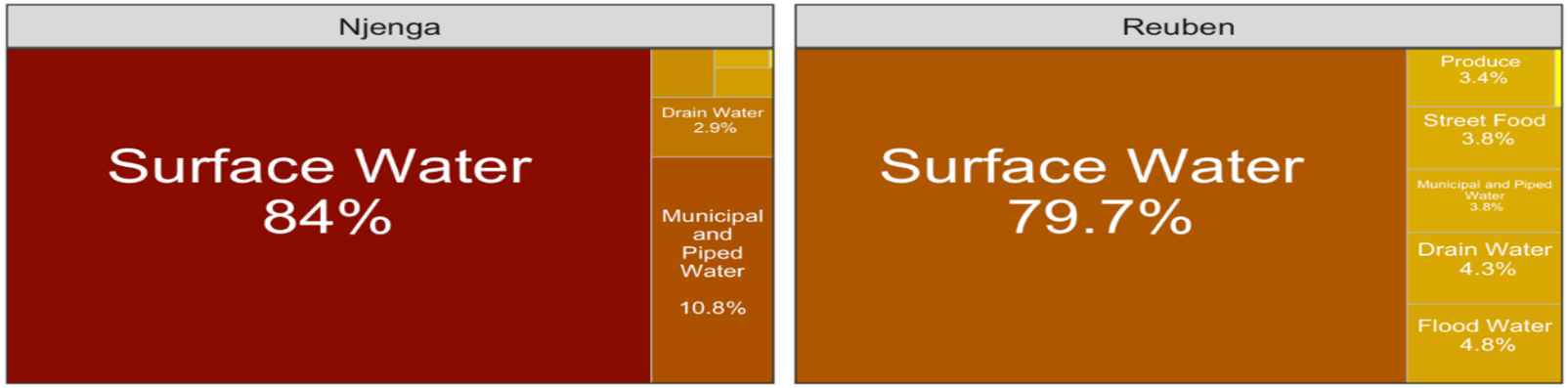
****** The unit for drinking water, flood water, open drain, and surface water is gc/mL. The unit for raw produce, soil, and street food is gc/g. The unit for public latrine is gc/swab.**

Pathways with substantial contribution to total exposure to *V. cholerae*

Adults



Children



- From survey responses and v. c detection;
- Adults are likely to contact *V .c* infections through drinking water, street food, raw produce and in a significant likelihood through contact with surface water.
- Children are highly exposed through surface water.

Multiple Dominant pathways

1) start with the oral cholera vaccine – immediate arrest of further transmission,
2) then target reducing exposure from the pathways that pose the greatest risk and are most feasible to intervene.

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National News

Outbreak So far, 14 of the 47 counties have recorded at least five cases of cholera

Kemri calls for vaccines roll-out in cholera crisis

By last week, about 82 people had died of cholera, a fatality rate of about two per cent

BY LEON LIDIGU AND HELLEN SHIKANDA

A cholera outbreak is spreading at an alarming rate, prompting the Kenya Medical Research Institute (Kemri) to ask the government to roll out a vaccination drive to curb infections.

Kemri wants vaccines that have been approved by the World Health Organisation (WHO) administered to stem a resurgence of cholera.

Last Thursday, the country recorded 109 new cases from eight counties, adding the cumulative number of confirmed cases since the onset of the outbreak last October to 4,295.

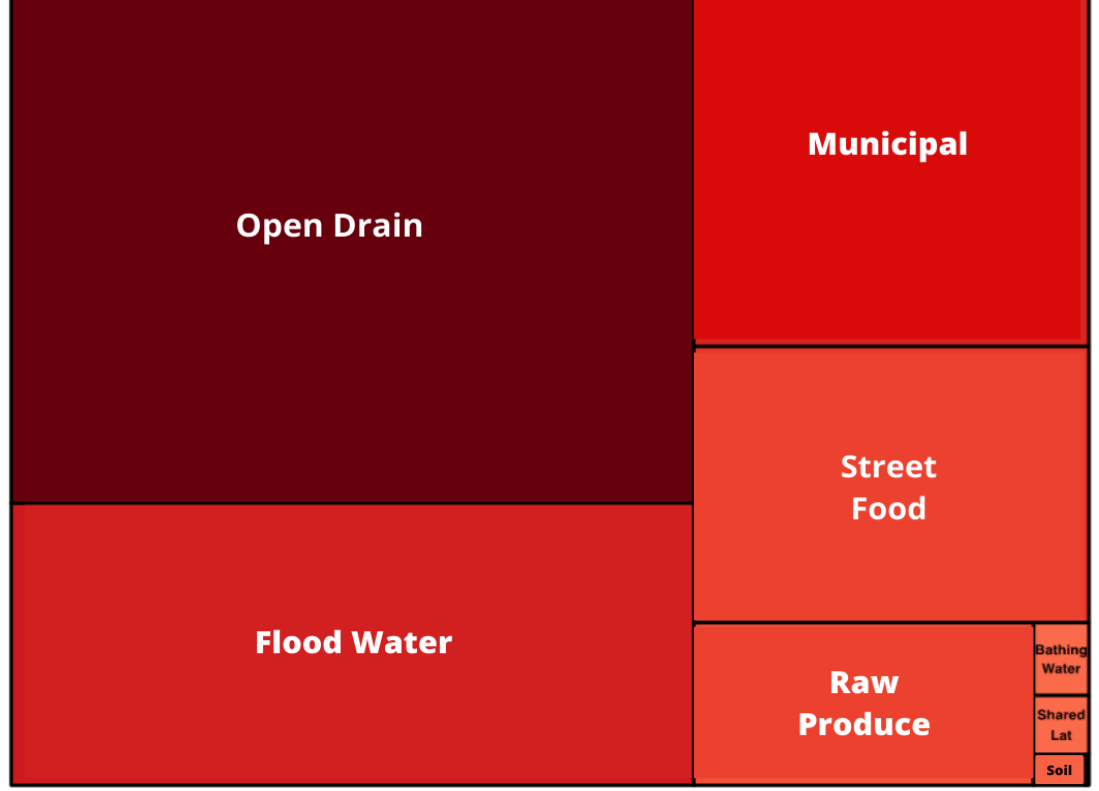
By last week, about 82 people had died of cholera, a fatality rate of about two per cent. WHO describes cholera as an acute diarrhoeal disease that can kill within hours if left untreated despite it being preventable.

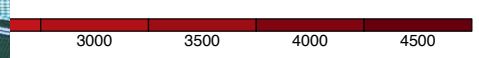
So far, 14 of the 47 counties have recorded at least five cases of cholera. Garissa Country has the highest burden with more than 1,000 people testing positive for the disease.

Other counties that have recorded cases include; Tana River (659), Nai-

Kemri wants vaccines that have been approved by the World Health Organisation administered to stem a resurgence of cholera. PHOTO | SHUTTERSTOCK

4,295





Feed back to the community, Stakeholder engagement and WASH awareness campaigns

- We conducted sensitization programs towards WASH awareness at Mukuru informal settlements.

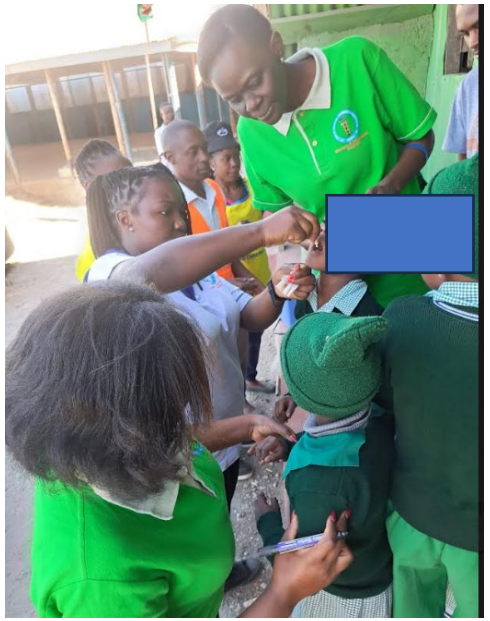
Summary of participants engaged during the sensitization program.

WASH awareness campaigns	Site	Number	Total
School WASH awareness	Mukuru Kwa Njenga (Jobenpha Primary school)	1group	4groups
	Kwa Njenga Primary School	1group	
	Mukuru Kwa Ruben (AEF Ruben Primary)	1group	
	Mukuru Kwa Ruben (Rejoice Primary)	1group	
Household WASH awareness	Mukuru Kwa Njenga (Pipeline)	12 Households	50 Households
	Mukuru Kwa Njenga (Wapewape)	13 Households	
	Mukuru Kwa Ruben (FTC & Mombasa)	15 Households	
	Mukuru Kwa Ruben (Gatoto)	10 Households	

- **Stakeholder engagement in decision making for WASH and overall Public Health** ” organized by APHRC.
- Shared study findings, experiences through the study and application of **SANIPATH tool** in assessing fecal contamination and *Vibrio cholerae* exposure to the environment.
- Mobilizing the uptake of free oral cholera vaccine (OCV).

Stakeholder engagement

Cholera oral vaccine (OCV).



Tackling cholera: WASH infrastructure and habits

Optimizing the Use of Oral Cholera Vaccine for Enhanced Impact

A Randomized Controlled Trial and Observational Study to Inform Vaccination Strategies in Kenya

1. To determine whether extending the dosing interval between the first and second doses of the whole cell killed oral cholera vaccine, Euvichol-S, elicits immune responses comparable in magnitude and duration with the manufacturer-recommended schedule.
    - *We will conduct a randomized controlled trial involving different age groups to determine if extending the time between vaccine doses can induce durable immunity to cholera.*
2. To assess the effectiveness of a large-scale, preventive OCV campaign in reducing the burden of cholera over three years in an endemic hotspot in Kenya.
    - *We will analyze vaccine coverage and monitor subsequent case trends to describe vaccine impact in sub-counties of Nairobi following the preventive OCV campaign conducted by the government*.

In summary

- We see more cholera outbreaks even ”off-season”
- Acquisition of MDR and ESBL on large MGE appears to contribute to longer term persistance oin the environment in endemic settings
- Multiple pathways are critical in transmission and spread
- Immediate intervention: roll out of OCV
- Medium term to Long term: Improved WASH infrastructure and WASH habits
- Improved socio-economic status for vulnerable populations

Field and Lab Team

Acknowledgment

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