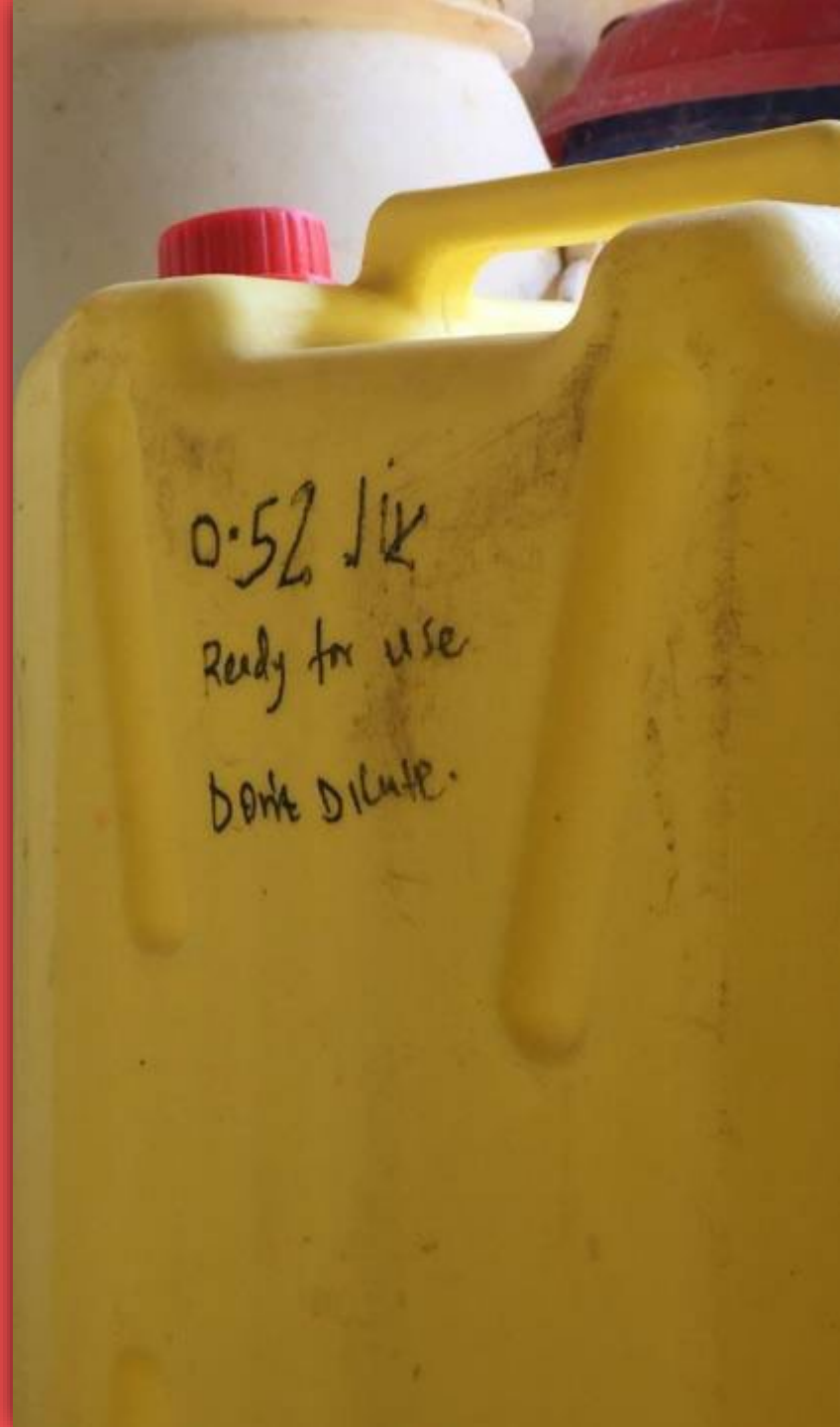
August 2021

Global Community of Practice (CoP) on decentralized chlorine production

Adam Drolet
Program Officer, PATH

PATH



Agenda

- Introduction & CoP overview
- Presentation & discussion: Onsite chlorine generation in eight Ghana healthcare facilities; Mr. Kofi Aburam; PATH
- Study description & discussion: Objectives and methods of a chlorine degradation study in Kisumu, Kenya; Mr. Jared Oremo; SWAP
- Wrap up

Please note: this webinar will be recorded.

1 Welcome and CoP introduction

2 Presentation: Ghana healthcare facility pilot

3 Study spotlight: Chlorine degradation study

Purpose

- The decentralized chlorine production **Global Community of Practice (CoP) aims to be an international consortium** of civil society organizations, private-sector companies, and individuals committed to advancing innovative chlorine generation technologies and service delivery models for disinfection and water treatment.
- The CoP seeks to **build on increasing global momentum and integration** of onsite chlorine generators in WASH services across the globe.
- The CoP will function as a **global learning, networking, and advocacy alliance** aiming to stimulate collaborative and transparent discussion among partners on lessons learned, evidence gaps, and candid feedback on challenges faced through the deployment and use of on-site chlorine generators.
- We seek a diverse, inclusive, and equitable platform that **fosters open and honest communication** and encourages a broad range of views and backgrounds. Please reach out with any suggestions, comments, or topics you wish to highlight.

Impact

- **Reduce the burden of water-borne diseases** in low- and middle-income countries by supporting the introduction and use of on-site chlorine generators for water treatment in household and community-based water systems.

- **Reduce the burden of hospital-acquired infections** in low-and middle-income countries through the introduction and use of on-site chlorine generators for improved infection prevention and control practices in healthcare facilities.

CoP structure

- Voluntary & open to all
- Rotating annual secretariat / integration into larger WASH in HCF CoP
- Quarterly meetings with rotating topics
- Previous meeting (May 2021):
  - **Technology**: Aqua Research STREAM Disinfection Generator
  - **Spotlight**: CRS No breach in chlorine supply project for health care facilities in Burkina, Ghana and Liberia
  - **Innovation**: Envicom digital data transmission & visualization
- Slides and recording available here:
  - Slides & Recorded webinar

Theme	Illustrative specific topics/questions
Technologies	• What technologies exist? • How do chlorine generators work • Efficacy & effectiveness • Advantages/disadvantages
Collaboration & learning	• **Learn how other orgs are applying these technologies for IPC and water treatment** • Synergies, establishing connections, exploring collaboration, and information exchange • **Experience with piloting and government engagement** • Research opportunities for young professionals
Implementation	• **Study design and methodologies** • Barriers and enablers to adoption • **Training approaches** • Large scale introduction and scale up strategies • Integration into and way to automate workflow processes • Indicators and monitoring approaches
Application and use cases	• Water treatment – with various water sources, complementary technologies, and community settings • Infection prevention and control – reduction of hospital acquired infections, AMR, and pandemic preparedness/outbreak control
Business/distribution models	• Decentralized chlorine production and distribution models • Business models for chlorine distribution (water tx or IPC) in rural/semi-urban areas

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August 2021

Onsite chlorine generation for Ghana healthcare facilities

Observational findings from the introduction of the Aqua Research STREAM Disinfection Generator in HCFs

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Kofi Aburam, Project coordinator
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GHANA HEALTH SERVICE
Your Health Our Concern

Healthcare acquired infections

- Healthcare acquired infections (HAI) **adversely affect hundreds of millions of individuals** worldwide and lead to a significant financial burden for patients and health systems.
- A a large-scale multi-centre HAI point-prevalence survey in Ghana found an overall HAI prevalence rate of **8.2%.**
- Improved WASH and IPC practices in health facilities can **reduce HAI prevalence rates by 10 – 70%** depending on the setting, baseline infection rates, and type of infection.

Gaps in IPC in health facilities

- Chlorine is a widely used, effective chemical disinfectant recommended for IPC in health care settings, yet **not consistently available**.
- Barriers to consistent chlorine access include **strained supply chains, transportation challenges, limited forecasting and insufficient budgets.**
- **Chlorine quality** (degradation of concentration) and challenges with **dilution calculations** due to varying chlorine stock concentration (3% to 70%) pose additional challenges.

Impact on patient safety

- Chlorine availability issues described by nurses, orderlies, pharmacy staff, and and hospital medical supply store managers point to two clear themes:
  - (1) **HCFs often receive inadequate supply or reduced volumes than requested of chlorine**, which leads to chlorine rationing and stockouts
  - (2) **patients are in some instances asked to bring chlorine** for their medical procedures

- Rationing leads staff to **selectively use chlorine** for certain cleaning practices until more supply is received by the facility or overdilute chlorine to make volumes last longer.

- During periods of chlorine stockout, **staff asked patients to bring in their own chlorine**; health facilities or **staff purchased small volumes of chlorine off the market**; or staff resorted to using **water and laundry detergent for cleaning and disinfecting**.

- Finally, at least one respondent questioned the **effectiveness of the chlorine** they were receiving and believed the low quality was contributing to increased infections. ..."current supplies budget is not sufficient for the necessary volume of patients".

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Strengthening IPC in HCFs

PATH seeks to strengthen the delivery of infection prevention and control practices in HCFs by collaborating with the GHS to evaluate and introduce the Aqua Research STREAM Disinfection Generator into the public health system.

The project has three principal objectives:

1. Generate national-level support for STREAM System adoption and develop national introduction and scale-up plans
2. Generate evidence through pilot evaluations in Ghana and Uganda
3. Support additional market priming and advocacy efforts

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Aqua Research STREAM Disinfection Generator

The STREAM Disinfectant Generator provides a continuous flow of 0.5% hypochlorite solution generated from common salt (NaCl) & water through electrolysis.

Chlorine concentration (FAC)	0.5%
Brine salinity	15 g/L
Chlorine production rate	4.8 L/hour
Chlorine generation mode	Continuous
Drinking water treatment rate	Up to 230,000L per day
Input power	110/220 V AC, 2 A, 50/60 Hz, 12 V DC, 16 A
System weight	8.2 kgs
Dimensions	42 x 33 x 17.3 cm

Pilot objectives

PATH conducted an observational pilot of the Aqua Research STREAM Disinfection Generator in eight healthcare facilities in Ghana.

The pilot had three objectives:

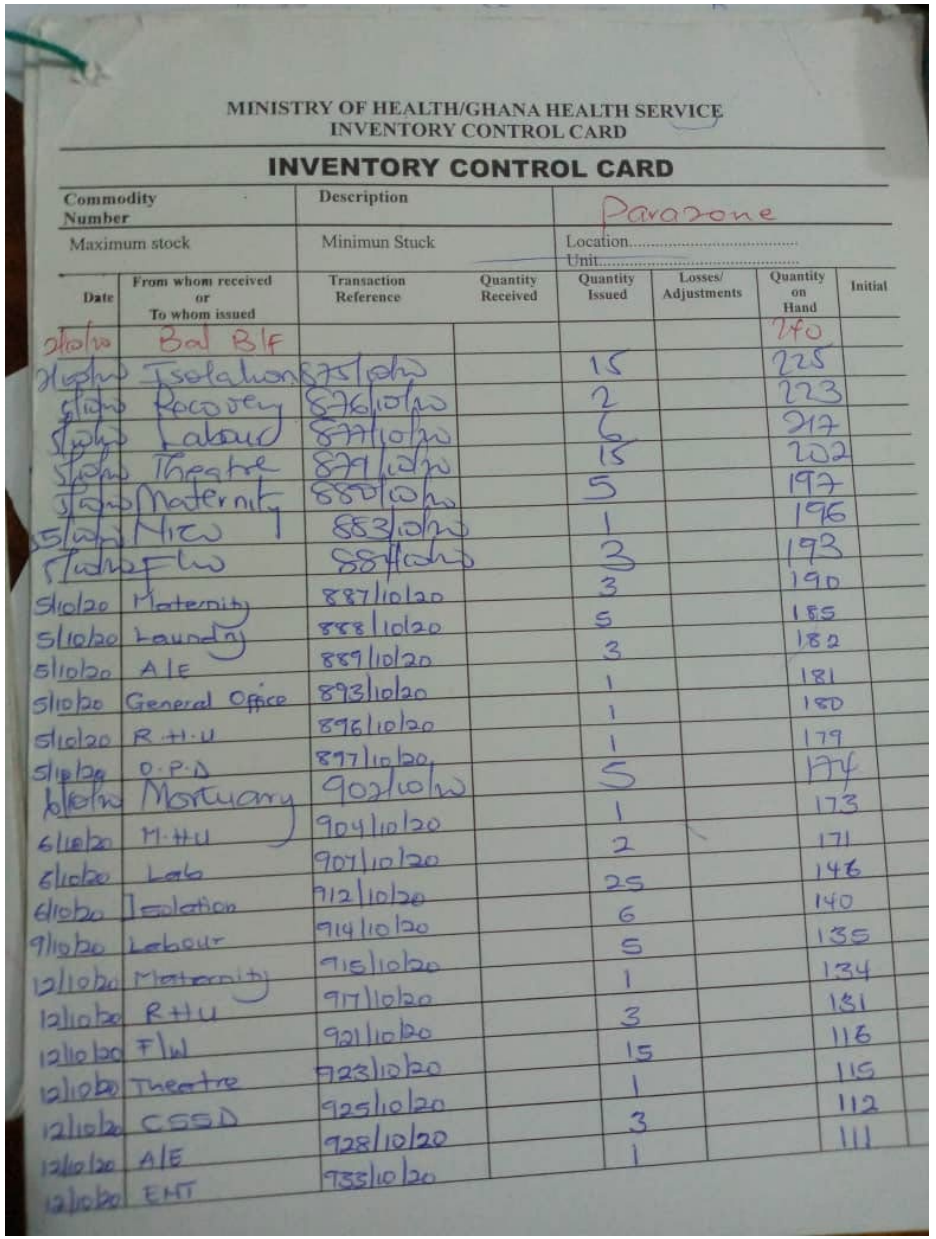
- Validate the performance of the STREAM
- Assess whether the use of the STREAM can improve chlorine availability, reduce the frequency and duration of chlorine stock outs and its impact on IPC practices.
- Assess whether the use of the STREAM can lead to 5-year chlorine supply cost savings

A secondary objective was incorporated during the pilot. This included pairing refresher trainings on the STREAM with GHS-led IPC trainings for HCF staff. Acceptability data on the STREAM and the training were collected at the end of the observational pilot.

Methods

Chlorine inventory and costs: Chlorine inventory, costs, and in-facility distribution of chlorine data are extracted from chlorine stock cards located in each hospital store. PATH staff collected the past 12 months (as available and with a minimum of 3 months of data) of chlorine inventory to develop a baseline denominator.

Chlorine production data: Chlorine generated by the STREAM during the pilot will collected from the STREAM unit itself and through user-completed chlorine monitoring forms capturing two weeks of chlorine monitoring forms capturing two weeks of chlorine production data.



MINISTRY OF HEALTH/GHANA HEALTH SERVICE
INVENTORY CONTROL CARD

INVENTORY CONTROL CARD

Commodity Number | Description: Paracetone | Location | Maximum stock | Minimum Stock | Unit

Date	From whom received or To whom issued	Transaction Reference	Quantity Received	Quantity Issued	Losses/ Adjustments	Quantity on Hand	Initial
2/10/20	Bal B/F					240	
2/10/20	Isolation	875/10/20		15		225	
2/10/20	Recovery	876/10/20		2		223	
2/10/20	Labour	877/10/20		6		217	
2/10/20	Theatre	879/10/20		15		202	
2/10/20	Maternity	880/10/20		5		197	
5/10/20	NICU	883/10/20		1		196	
5/10/20	Fluid Flow	884/10/20		3		193	
5/10/20	Maternity	887/10/20		3		190	
5/10/20	Laundry	888/10/20		5		185	
5/10/20	A/E	889/10/20		3		182	
5/10/20	General Office	893/10/20		1		181	
5/10/20	R+H+U	896/10/20		1		180	
5/10/20	O.P.D	897/10/20		1		179	
6/10/20	Mortuary	902/10/20		5		174	
6/10/20	M+H+U	904/10/20		1		173	
6/10/20	Lab	907/10/20		2		171	
6/10/20	Isolation	912/10/20		25		146	
9/10/20	Labour	914/10/20		6		140	
12/10/20	Maternity	915/10/20		5		135	
12/10/20	R+H+U	917/10/20		1		134	
12/10/20	F/W	921/10/20		3		131	
12/10/20	Theatre	923/10/20		15		116	
12/10/20	CSSD	925/10/20		1		115	
12/10/20	A/E	928/10/20		3		112	
12/10/20	EMT	933/10/20		1		111	

Pilot locations

Pilot sites include public, private, and not-for-profit facilities, as well as various levels of care.

No.	Region	District	Facility name	Facility level (district/regional hospital)	Public Private for profit Public not for profit	Date of installation
1	Eastern	Lower Manya Krobo	Akuse Government Hospital	District Hospital	Public	11/18/2020
2	Eastern	Atiwa	Enyiresi government Hospital	District Hospital	Public	11/17/2020
3	Eastern	Kwahu South	Kwahu Government Hospital	District Hospital	PNFP	11/17/2020
4	Eastern	Lower Manya Krobo	St. Martin Hospital	District Hospital	Public	11/18/2020
5	Eastern	Kwaebibirem	Asuom Health Center	Health Center	Public	11/20/2020
6	Eastern	Nsawam-Adoagyiri Municipality	Adoagyiri Health Center	Health Center	Public	11/20/2020
7	Eastern	New Juaben North	Oyoko Health Center	Health Center	Public	11/19/2020
8	Eastern	Yilo Krobo	Nkurakan Health Center	Health Center	Public	11/19/2020

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Observational pilot results

Results

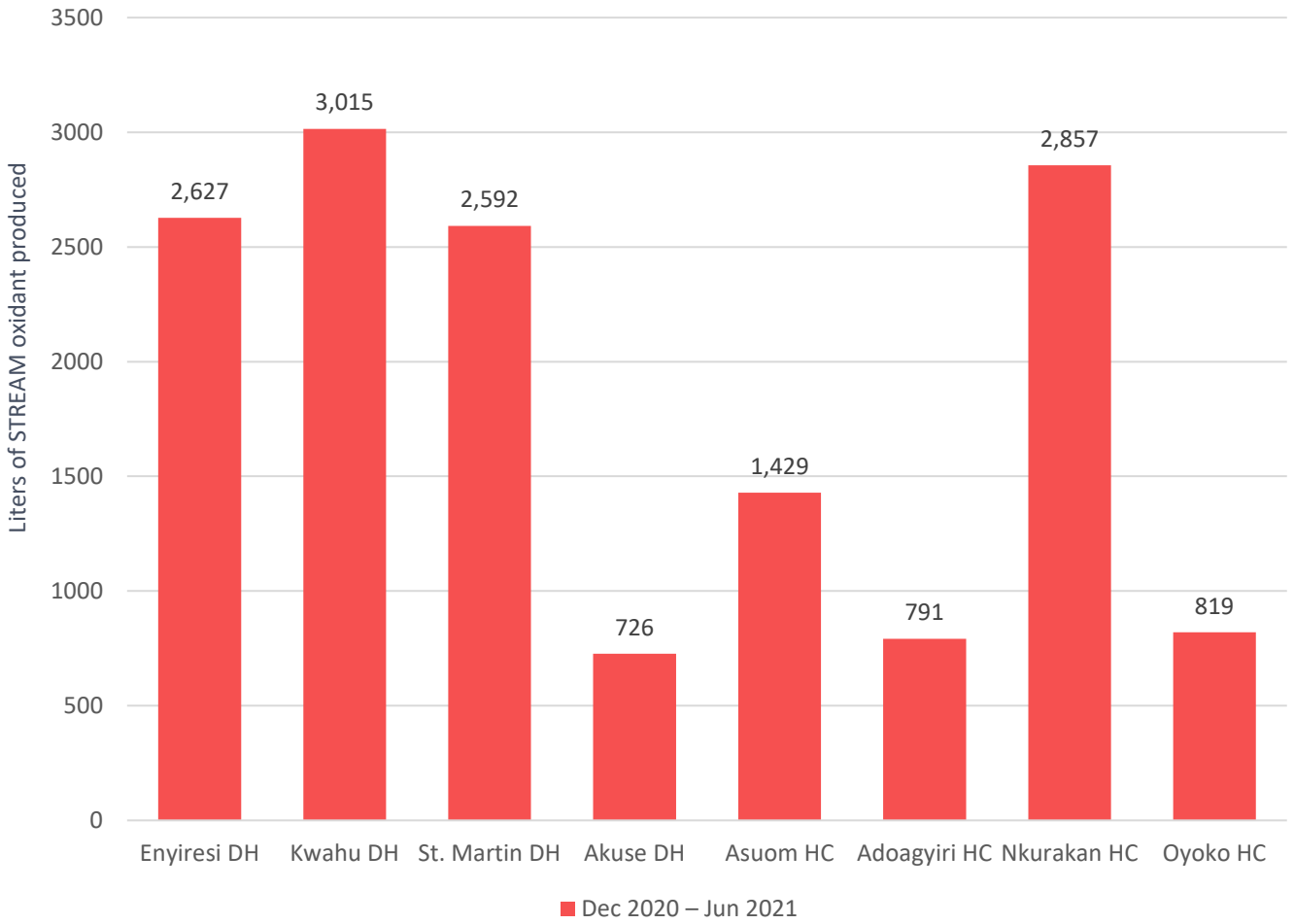
Performance

- **14,859 liters of 0.5% chlorine disinfectant produced to date (Dec 2020 – Jun 2021)**

Cumulative volume (L) of 0.5% chlorine disinfectant produced and used

Facility name	Dec 2020 – Jun 2021
Enyiresi DH	2,627
Kwahu DH	3,015
St. Martin DH	2,592
Akuse DH	726
Asuom HC	1,429
Adoagyiri HC	524
Nkurakan HC	2,857
Oyoko HC	819
Total	**14,589 Ls**

Cumulative volume (L) of 0.5% chlorine produced and used

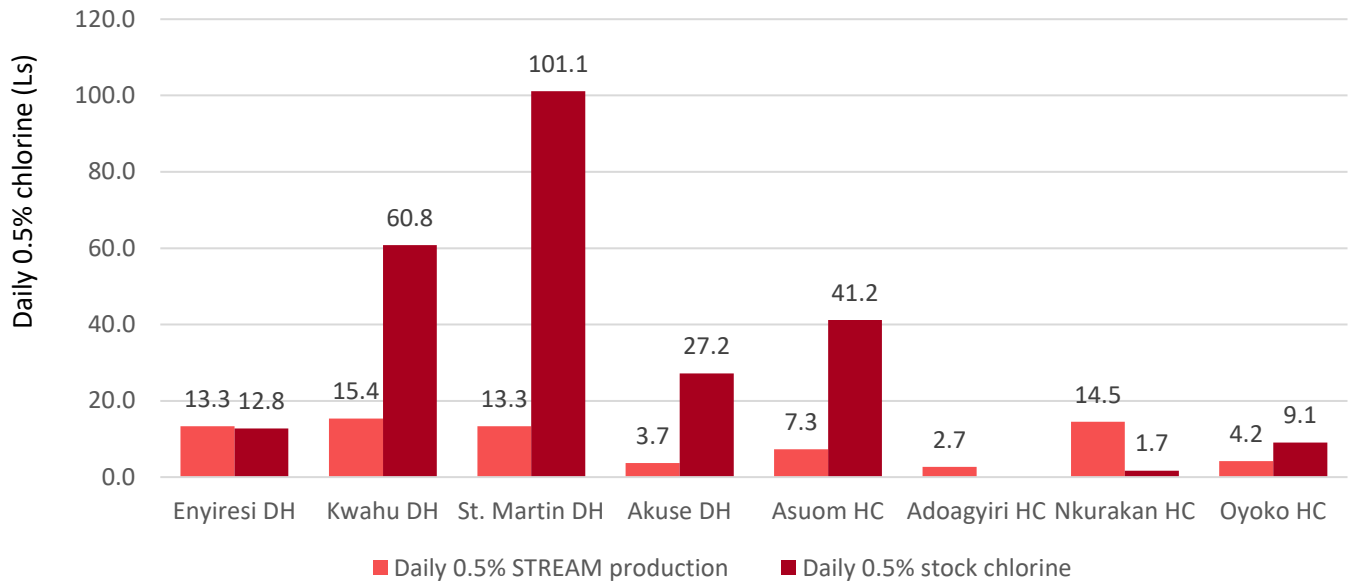


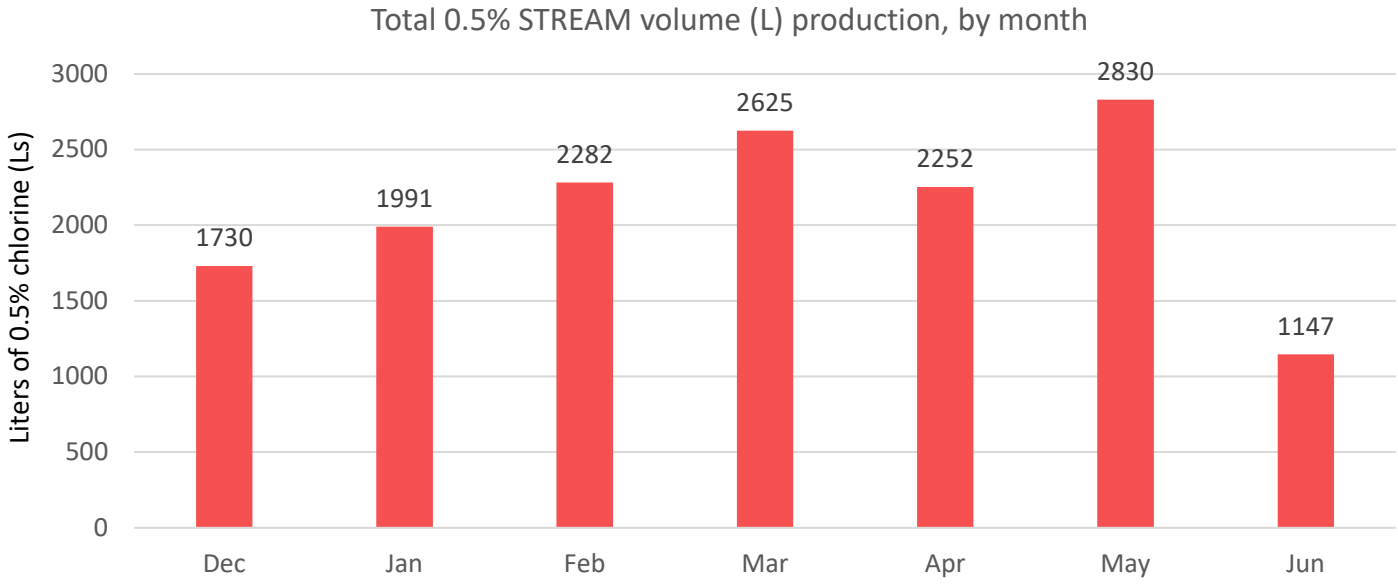
Results

Performance

- In 2 facilities (2/8), users are generating more chlorine with STREAM than baseline stock volumes.
- Reasons for limited volume production include challenges with device, awareness within facility of STREAM, and lack of familiarity with device. Increasing trend in production, revised components, and hybrid procurement/generation could eliminate chlorine stock outs.
- District hospitals may need two devices to address demand, whereas HCs may suffice with one unit. A hub and spoke model could be an effective way of addressing chlorine needs with production in small DHs or large HCs.
- General increase in volume production per month. June production volume is significantly less due to shorter monitoring period that month

Daily 0.5% STREAM volume (L) production compared to baseline chlorine volume stock





Results

Performance issues

- The STREAM devices experienced three main hardware issues
- Aqua Research has redesigned these components and all future STREAM devices will have upgraded components.

Issue	Component redesign
Leaking reaction chamber --Cause: Scaling in the reaction chamber and/or the outlet ports led to clogging and build up of pressure inside the cell, which led to leaking.	• The internal housing has been enhanced to add boss sections to support the bolts. • An emergency pressure relief rupture disk was added to the brine inlet port of the cell to provide a point of pressure relief for the cell when the cell needs to be cleaned. • The upgraded cathode housing includes an outer titanium plate that will prevent the cathode housing from warping (where oxidant was leaking).
Power supply and voltage stabilizers failed --Cause: Severe power surges lead to tripped thermal switches, damaged power componentry, and failed surge protectors	• Aqua Research redesigned the power supply to include a 10,000 V surge protector and added in an 42A connector from the power supply to the control box.
Control box issues --Cause: weak connections in the circuit boards	• All the socket connectors on the circuit boards and mating connectors to stronger, more robust, click to connect connectors have been replaced to prevent accidental shorts and wires becoming dislodged during transport. • The connector between the power supply and the control box is being upgraded to a 42A connector, from 32A, to prevent overheating and all connections will be soldered. • Circuit boards will be enabled to remotely transmit performance data.

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Results

Chlorine stockout

- Prior to the pilot, Ghana HCFs faced an average of 1.6 chlorine stockouts per year each lasting roughly one month. As a result, HCFs face periods of chlorine stock outs lasting an average of 44.8 days per year.

	Ave stockout length (days)	Ave stockouts / year	Average # of days per year without Cl
Ghana overall average (n=8)	28.0	1.6	44.8

- Health centers face higher rates of chlorine stockout duration, but fewer number of stock outs.

	Ave stockout length (days)	Ave stockouts / year	Average # of days per year without Cl
Health center (n=4)	47.5	1.3	61.8
District hospital (n=4)	18.3	1.8	32.9

- During the pilot period, none of the eight healthcare facilities experienced a chlorine stock out.

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Results

Cost analysis

32% average cost savings across all facilities due to STREAM

Cost of chlorine: commercial chlorine vs STREAM

	Commercial chlorine (Jik)	STREAM	Cost savings (USD/%)
Total cost of 14,859 Ls of 0.5% chlorine volume produced to date	$18,014 (105,920)	$ 12,173 (71,580)	**$ 5,840 (34,340)**
Average cost per liter of 0.5% chlorine	$ 1.21 (7.13)	$ 0.82 (4.82)	**$ 0.39 (2.31)**

Chlorine cost savings from STREAM across facility levels

	Modeled 5-year chlorine cost savings from STREAM (0.5%; USD)	Modeled 5-year chlorine cost savings from STREAM (0.5%; %)
District hospital (n=4)	$ 39,278	**70%**
Health centers (n=3)	($ 2,859)	**-14%**

- Adoagyiri is not included in cost savings analysis because the baseline chlorine cost of using tablet is inconsistent
- Cost saving is mostly observed in district hospitals which use more chlorine
- Facility with chlorine need higher than 3,000L could save from using STREAM

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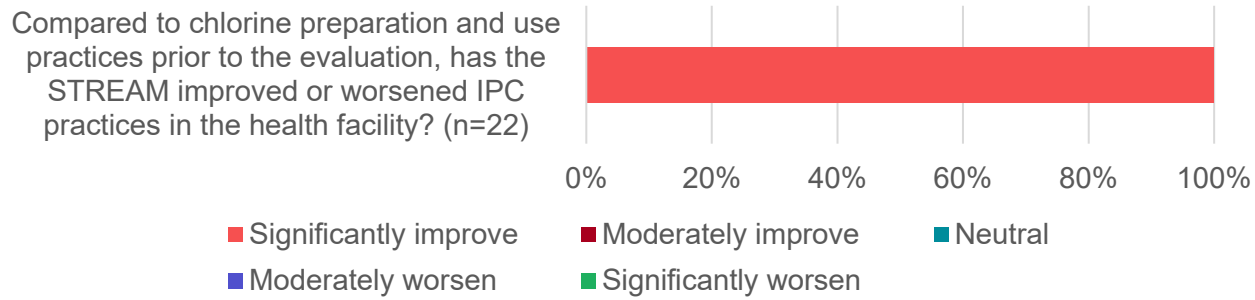
Results

Acceptability

- 100% of clinical managers, hospital administrators, and device users agreed the STREAM has improved IPC practices in three ways:
  - Increased chlorine availability has led to increased IPC practices and cleaning
  - Perception that patient environments are safer and cleaner
  - Simplified chlorine distribution processes and cost savings

STREAM effect on IPC practices



"'The ready availability of chlorine has made it easier for staff to carry out IPC practices as compared to previously where there was acute shortage occasionally."HA01

“With the introduction of the device and subsequent IPC training, staff understand better the importance of proper IPC practices. This has resulted in improved practices.” DU03

"Chlorine is now consistently available and so IPC practices are being improved and increased. I believe patient safety has also improved due to this." CM05

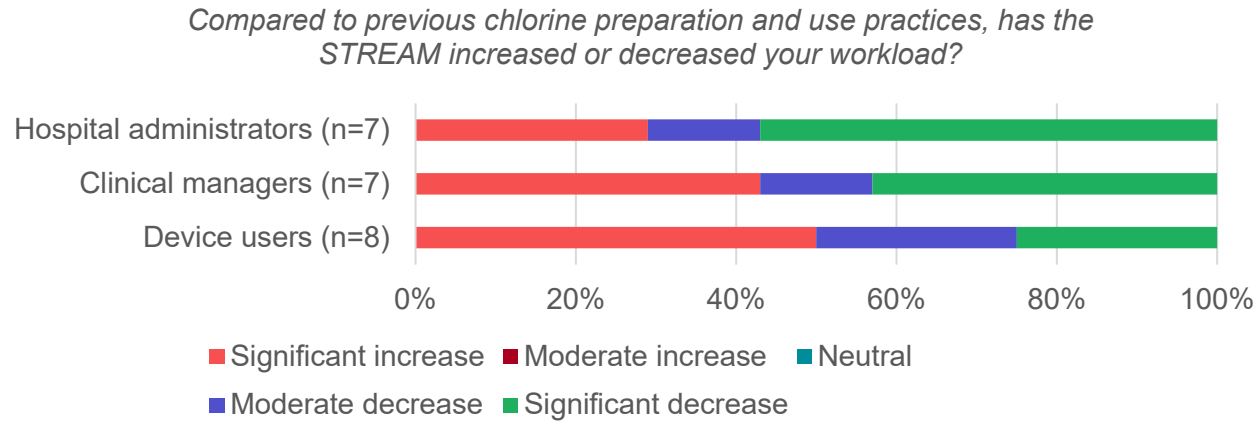
"Distribution of chlorine from STREAM is much easier. No need to depend on availability of stores keeper to collect chlorine." CM03

Results

Acceptability

- Feedback was mixed regarding the effect of the STREAM on workloads.
- Increase in workload factors
  - Increased chlorine availability led to a higher volume of infection prevention control practices conducted
  - Dedicated device users – though only for production team
- Decrease in workload factors
  - No dilution required for disinfection (also eliminating errors)
  - Quality of chlorine from STREAM was visibly noticed – previous chlorine required multiple applications to see effect
  - Elimination of lengthy procurement process

STREAM effect on workload



“There's no need for dilution so workload has reduced” DU06

"It also doesn't require multiple application before you see the effect." HA05

“I no longer have to go through the long bureaucracy and processes needed for the purchase of commercial chlorine. I no longer have to struggle to allocate resources for chlorine procurement.” DU08

"It has increased workload because the availability of chlorine is consistent and there's no need to be economical with applying it in IPC practices hence increased workload with practices." CM03

Summary & next steps

- Healthcare facilities are **generating significant volumes of chlorine** with the STREAM devices.
- We are gaining a **stronger understanding of chlorine demand in healthcare facilities,** which will help determine where and how many STREAM units are appropriate.
- **Performance issues have led to redesigns**, which will improve STREAM robustness and include in all future units.
- The STREAM has led to **increases in workloads**, but also **increase in the delivery of IPC practices**.
- **Aqua Research very responsive** and receptive to addressing performance and design issues. Currently developing a post-sales support plan.
- Healthcare facilities have so far experienced **32% cost savings** on average by using STREAM.
- Continue **STREAM introduction with IPC training**.
- **Product registration** underway with goal of getting product category listed in essential equipment list

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For more information contact:

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Global Community of Practice on Decentralized Chlorine Production

Jared Oremo, Lab/Research Manager

19th August 2021

STREAM Disinfectant Generator Oxidant Concentration Study to Improve Disease Prevention and Control

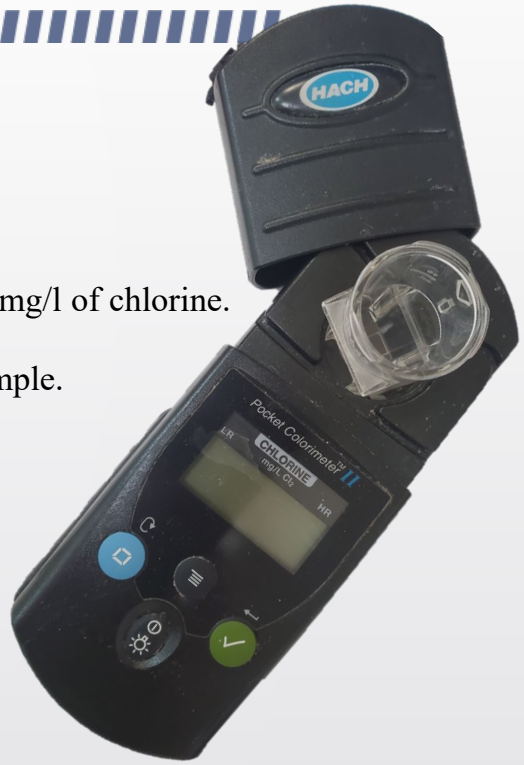
Objectives:

1. **Determine the rate of STREAM oxidant concentration degradation over time:**
    1. Two (2) health facilities in Kisumu County, Kenya
2. **Compare the rate of oxidant degradation over time for:**
    1. STREAM Oxidant (standard-non-stabilized)
    2. Stabilized STREAM Oxidant
    3. Commercial Bleach

Study Methodology

- **Two hospitals selected in Kisumu County by the MoH for STREAM installation:**
  - Nyakach Sub County Hospital
  - Nyando Sub County Hospital
- **Produce 20 Liters of STREAM Oxidant in each Health Care Facility**
  - Primary Indicators:
    - pH
    - FAC (%)
    - Temperature
- **Stream Oxidant solution was divided into 6 x 2 liter bottles**
  - 3 opaque 2 liters bottles with non-stabilized STREAM oxidant
  - 3 opaque 2 liter bottles with stabilized STREAM oxidant
- **To stabilized STREAM oxidant-2 grams of Sodium Hydroxide Powder was measured in 1 liter of Stream Oxidant until pH of 12 was attained.**
- **Obtain Commercial Bleach of 3.5% divided in 300 mls opaque contained placed in cool place in Laboratory.**

Study Method cont'd



- **To determine FAC (Free Available Chlorine) of each sample**
  - HACH Pocket Colorimeter on High Range (0-8ppm)
  - Tap water with a chlorine residual in the water was used for the dilution water. Tap water from the Kisumu city contains 0.2-1.1mg/l of chlorine.
  - Tap water FAC levels are measured multiple times per day. Chlorine residual value of the tap water is subtracted out of each sample.
- **STREAM Oxidant (non-stabilized and stabilized) is diluted down by 1000**
  - Measured out 10 ml of Oxidant demand free dilution water to 1ul of sample. (OR 1ml of Oxidant into 1 litre of water)
- **Bleach is diluted by 10,000;]**
  - Measure out 100 ul of 3.5% Commercial Bleach into 1000 mls of tap water.
- **Obtain the FAC value of the sample and subtract out the tap water FAC value and multiply by the dilution factor to get the sample concentration**
- **We measured each sample three days in a week for 2 months till ppm is reduced by 50%**

Results

- **Final Report Expected November 2021**
- **Contact Jared Oremo (jared@swapkenya.org) for more information**

Next call

November 2021

Focus on water treatment applications & manufacturer presentation

Call for ideas! Send them to adrolet@path.org

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Technologies	• What technologies exist? • How do chlorine generators work • Efficacy & effectiveness • Advantages/disadvantages
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Application and use cases	• Water treatment – with various water sources, complementary technologies, and community settings • Infection prevention and control – reduction of hospital acquired infections, AMR, and pandemic preparedness/outbreak control
Business/distribution models	• Decentralized chlorine production and distribution models • Business models for chlorine distribution (water tx or IPC) in rural/semi-urban areas


OXIDIZER
5.1
Manufactured by:
Sree Rayalaseema H.-Strength Hypo Ltd.
0·52 lit
Ready for use
Don't Dilute.

Thanks!