Introduction of a novel chlorine generator in Ghana, Uganda, and Ethiopia public health systems

A learning brief series on the Aqua Research STREAM™ Disinfectant Generator

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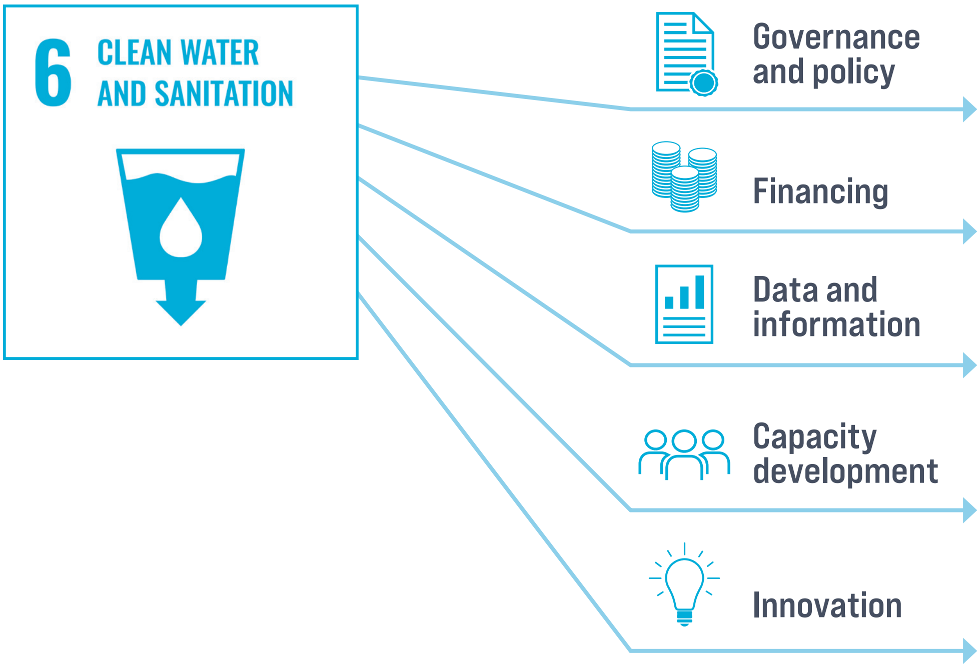
About the STREAM Learning Brief Series

Poor water, sanitation, and hygiene practices contribute to the spread of infections and negative health outcomes in communities and health care settings. Globally, roughly 3.85 billion people use health facilitates that lack basic hand hygiene services, while 1.7 billion people access health facilities that lack basic water services.[1] Achieving the United Nations Sustainable Development Goal 6 (SDG 6)—ensuring access to water and sanitation for all—demands innovative and strategic solutions. One such solution is the Aqua Research STREAM™ Disinfectant Generator (STREAM). The STREAM is an onsite chlorine generator that uses common salt and water to generate liquid chlorine that meets global standards for intermediate-level disinfection of surfaces in healthcare settings and can be used for treating drinking water.

With funding from the Conrad N. Hilton Foundation and in collaboration with ministries of health, this learning brief series provides real-world examples and lessons learned from implementing the STREAM in three countries: Ghana, Uganda, and Ethiopia.

It describes how PATH in collaboration with ministries of health is using the SDG 6 Global Accelerator Framework to introduce and scale up the STREAM on a national level. Each issue focuses on one of the five SDG 6 accelerators:



[1] *Progress on WASH in health care facilities 2000–2021: special focus on WASH and infection prevention and control*. Geneva: World Health Organization and the United Nations Children's Fund (UNICEF), 2023. Licence: CC BY-NC-SA 3.0 IGO. https://iris.who.int/bitstream/handle/10665/366657/9789240058699-eng.pdf?sequence=1.

Cover photos: PATH/Thomas Mugumya, PATH/Patrick McKern, PATH/Adam Drolet

INTRODUCTION OF A NOVEL CHLORINE GENERATOR
IN GHANA, UGANDA, AND ETHIOPIA HEALTH SYSTEMS

PATH

Learning brief: The role of government champions in national adoption of the Aqua Research STREAM™ Disinfectant Generator

February 2024

A health center in North Mecha, Ethiopia using a STREAM device.

Investing in relationships: Government champions are critical for driving national policy and regulatory approvals and health system adoption

Starting in 2018, PATH has cultivated strong relationships with government actors responsible for water, sanitation, and hygiene (WASH) services in health facilities across various levels of the health system (national, regional, district or woreda). In these settings, we take a collaborative approach to project design and implementation with government leaders, jointly implementing activities such as assessing evidence gaps and conducting evaluations, codeveloping policy roadmaps and introduction strategies, and piloting activities that integrate WASH innovations into routine health service delivery.

Our collaborative approach has enabled us to achieve key milestones on the introduction of a novel chlorine generator—the Aqua Research STREAM™ Chlorine Generator (STREAM)—in Ghana, Uganda, and Ethiopia. Illustrative successes include: national MOH approval for the STREAM introduction in the Uganda health system; certification of STREAM chlorine by national drug and pharmaceutical regulatory bodies in Uganda, Ethiopia, and Ghana (pending final result); expansion of STREAM evidence base through four codesigned studies between PATH and national/regional/district health service leaders; and integration of the STREAM into routine infection prevention and control (IPC) training and supervisory activities in Ghana and Uganda. Below we describe specific examples of how work by PATH and key government champions led to the various successes.

STREAM device producing 0.5% mg/L chlorine for disinfection. Photo: PATH/Thomas Mugumya

This document is part of the STREAM learning brief series and focuses on how strong government partnerships can drive successful introduction of the Aqua Research STREAM™ Disinfectant Generator (STREAM) across national health care systems. It explores the critical role of government champions in navigating approvals, fostering key partnerships, and ultimately delivering safe and effective water, sanitation, and hygiene services in health facilities.

Governance: WASH service delivery in health facilities

In all three project countries-Ethiopia, Ghana and Uganda-WASH services in health facilities are governed by the respective MOHs. Typically, this includes responsibilities such as developing national guidelines and policies for the delivery of WASH services, supporting capacity development for health staff and implementation of WASH activities in health facilities, and establishing national budgets and standardized monitoring systems. Within MOHs, oversight of WASH services is often nested within clinical care departments. For example, in Uganda, the Clinical Services Department (CSD) within the MOH is responsible for policies, standard operating procedures, and guidelines on clinical care; information, education, and communication materials; and trainings—whereas the Environmental Health Department is focused on infrastructure, water availability, and water quality. WASH services are considered a core element of clinical care. In Ghana, the Ghana Health Service's Institutional Care Division is responsible for leading, supporting, and providing oversight to client-centered, high-quality clinical services, which includes WASH services, across all service delivery levels in the Ghana health system. In Ethiopia, the Hygiene and Environmental Health Directorate of the Federal Ministry of Health is responsible for overseeing policy, strategy, and interventions of environmental determinants on health, including WASH services, within the health system. This directorate published the WASH in HCF guidelines (2021) for the country. In each country, PATH has established strong relationships with directors from each of these departments, which has helped inform and drive project objectives, generate ownership and buy-in for the project, and further integrate the device into national health systems.

Uganda

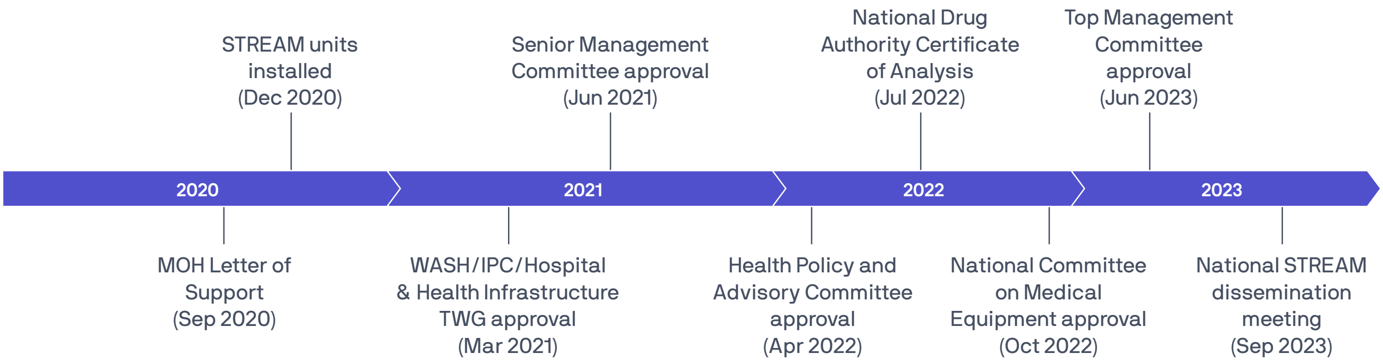
PATH's collaboration with the Ministry of Health's (MOH) Clinical Services Department (CSD) Acting Commissioner, Dr. Rony Bahatungire, has been instrumental for securing policy and regulatory approvals for the STREAM's introduction into the public health system. Starting in 2019, PATH and Dr. Bahatungire co-outlined a roadmap for navigating policy approval processes; designed STREAM evaluations to generate evidence on the performance, acceptability, and cost impact of the STREAM in health facilities; and jointly prepared and presented results to several governmental policy approval bodies (see Figure 1).

Starting in 2021, PATH and the MOH/CSD presented to and secured approvals from several governmental groups that paved the way for national approval. These include the Water, Sanitation, and Hygiene (WASH)/IPC subcommittee, IPC technical working group, and hospital and health infrastructure technical working group approvals in March 2021; the MOH Senior Management Committee approval in June 2021; and the Health Policy and Advisory Committee approval in April 2022. In July 2022, the National Drug Authority issued a certificate of analysis verifying the STREAM produced a chlorine concentration of 0.5% ± 0.1% mg/L, as indicated in the product specifications. In October 2022, the National Advisory Committee on Medical Equipment issued a report concluding, "The device is recommended for Health Centres III and IV to General Hospital Level."

As a final step for national approval, PATH and Dr. Bahatungire jointly presented STREAM results to the MOH's Top Management Committee (TMC) on the STREAM evaluation in June 2023. PATH and Dr. Bahatungire presented the performance, cost, and acceptability results from ten STREAM devices installed across ten Central and Western Region health facilities to Uganda's Minister of Health, Dr. Jane Ruth Aceng Ocero, and the TMC. Following their review, the TMC approved the use of the STREAM in Uganda's health care system, officially enabling government-led introduction into the public health system, as well as providing a strong vote of confidence for uptake and use in private-not-for-profit and private-for-profit health facilities.

> ***"As the Ministry of Health, we are in full support of this technology. I call upon the leadership of the private health facilities and private-not-for-profit health facilities to embrace this new technology to solve the challenges of stockouts and the effects of corrosion of medical equipment and damage to linen and gowns."***
>
> *– Dr. Henry G. Mwebesa, Director General of Health Services, Uganda MOH*

FIGURE 1. **STREAM policy and regulatory approvals, Uganda.**



Abbreviations: IPC, infection prevention and control; MOH, ministry of health; TWG, technical working group; WASH, water, sanitation, and hygiene.

The June 2023 TMC approval, which officially enables government institutions to purchase STREAM devices and provides a strong vote of confidence for uptake and use in private-not-for-profit and private-sector health facilities, was the result of roughly three years of advocacy, evidence generation, and a close working partnership between the MOH/CSD and PATH.

Policy and regulatory approvals for STREAM introduction in Uganda

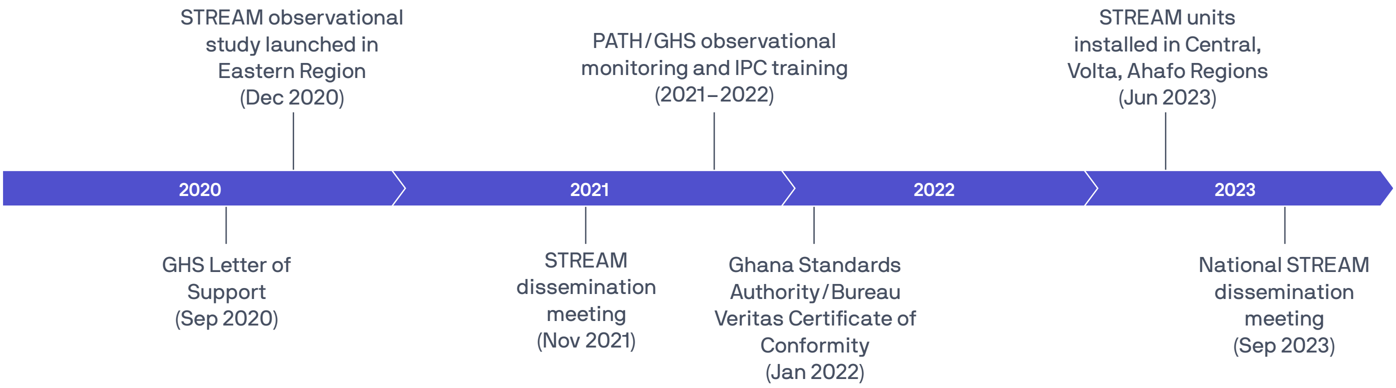
July 2022	**National Drug Authority** Certificate of analysis certifying the STREAM chlorine complies with US Pharmaceutical and British Pharmaceutical (0.42% ± 0.1% mg/L) specifications (NDA/DLS/FOM/030B).
October 2022	**National Committee on Medical Equipment Approval** Observational study concluding the STREAM is recommended for national introduction in Uganda (RSPS 21 10 22).
June 2023	**Ministry of Health Top Management Committee** TMC approves the use of the STREAM in the Uganda health system (TMC Min. No 7/23/2023).
TBD (2024)	**Uganda National Bureau of Standards** Aqua Research will contract a certified pre-export certification service provider in the country of export (the United States) to inspect and verify the STREAM, with the goal of securing a UNBS import clearance certificate for the STREAM.
TBD (2024)	**Uganda Revenue Authority** Aqua Research or its in-country distributor to submit a dossier package consisting of a user manual, certificate of conformity, certificate of analysis, commercial invoice, packing list, airway bill/bill of lading, import license, and letter or certificate of origin to determine the appropriate customs procedures and tariff/harmonized system code. Once received, the URA will review and issue a letter to the Director General of Medical Services in the Ministry of Health informing him/her that the company/entity is importing disinfectant generators. The Director General of Medical Services will write to the Assistant Commissioner of Trade at URA requesting a tax waiver on the disinfectant generators. Following the URA's tax determination, demurrage and any other handling fees are paid.

Abbreviations: TMC, Top Management Committee; UNBS, Uganda National Bureau of Standards; URA, Uganda Revenue Authority.

Ghana

Starting in 2018, PATH began working closely with the Ghana Health Service's Institutional Care Division (GHS/ICD) and its Director, Dr. Samuel Kaba, to strengthen the delivery of WASH and IPC services in health facilities through the evaluation and introduction of on-site chlorine generators. In September 2019, the GHS/ICD and PATH teams collaborated to design and launch an observational study design involving eight STREAM units in the Eastern Region. Following delays due to the SARS-CoV-2 pandemic, in December 2020, PATH and the ICD team co-led installations and training sessions with STREAM users across eight health facilities (see Figure 2). Over the next 18 months, Eastern Region biomedical engineers regularly accompanied PATH on monitoring trips to build familiarity and hands-on experience troubleshooting and repairing STREAM devices. The GHS/ICD staff frequently joined PATH on monitoring visits to these facilities, eventually leveraging these monitoring trips (starting in December 2021) to conduct in-service IPC refresher training for health staff. In June 2022, PATH officially turned over the operation

FIGURE 2. **STREAM policy and regulatory approval, Ghana.**



Abbreviations: GHS, Ghana Health Service; IPC, infection prevention and control.

and maintenance/repair of the STREAM in the Eastern Region to the regional health management team, health facilities, and Eastern Region biomedical staff.

Results from this study led the Eastern Region health directorate to commit to providing ongoing funding for STREAM chlorine production supplies (salt, vinegar). In August 2022, four additional STREAM units were installed in two district hospitals and two health centers by the Eastern Region health management team. All STREAM maintenance and repair services have been transferred to PATH-trained Eastern Region biomedical staff, who continue to provide technical assistance to STREAM users. The success and sustained adoption of the STREAM devices in the Eastern Region led Dr. Kaba to publicly voice his support and confidence in the STREAM and call for national scale-up of the device, starting with an expansion in the Volta, Ahafo, and Central Regions.

In parallel with the observational study and with the intent of moving toward STREAM product registration in Ghana, Aqua Research contracted Bureau Veritas to assess the STREAM's compliance with the Ghana Standards Authority's safety measures (IEC 61010-1:2010) for electrical equipment. In January 2022, Bureau Veritas issued a certificate of conformity for and on behalf of the Ghana Standards Authority for the STREAM device. The following month (February 2022), PATH held a series of meetings with the GHS/ICD, the Ghana Standards Authority, and the Ghana Food and Drug Authority (FDA) to review and agree upon the classification of the STREAM. Ultimately in January 2023, the Ghana FDA issued a final determination stating the STREAM "does not fall within the definition and classification rules per the Authority's Guidelines for the Registration of Medical Devices." This determination is a significant milestone for the milestone for the project as it simplifies the registration, import, and market adoption of the STREAM in Ghana.

In June 2023, PATH and the GHS/ICD jointly installed 18 STREAM devices in 12 Central, Volta, and Ahafo Region HCFs. Similar to the observational monitoring in 2020–2022, the GHS and PATH coupled the introduction and use of STREAM devices with IPC assessments and supportive supervision visits, reaching more than 200 health care professionals from June to November 2023. Additionally, PATH and the GHS ensured regional biomedical engineers from the Volta, Central, and Ahafo Regions were trained on technical maintenance and repair procedures and facilitated connection with biomedical engineers from the Eastern Region.

Finally, PATH and the GHS/ICD have submitted a request for laboratory analysis and certification by the Ghana FDA on the chlorine concentration of the STREAM. PATH and the GHS/ICD Director expect the regulatory and combined evaluation results (expected March 2024) will provide a strong case for the policy adoption of the STREAM as a tool for enhancing IPC in HCFs by GHS/MOH leadership in 2024.

Policy and regulatory approvals for STREAM introduction in Ghana

January 2022	**Ghana Standards Authority** Certificate of conformity issued by Bureau Veritas certifying the STREAM's compliance (GHS 2021 357364 / 0001).
January 2023	**Ghana Food and Drug Authority** The letter confirms that the device does not fall within the definition and classification rules per the Authority's Guidelines for the Registration of Medical Devices. In short, we do not need to register the STREAM with the Ghana FDA based on their current regulations.
April 2023	**Ghana Health Service collaborates and supports regional expansion** GHS approves installation and evaluation of 18 STREAM devices in Ahafo, Volta, and Central Regions (GHS/ICD/L2023).
February 2024 (estimated)	**Ghana Food and Drug Authority** Certificate of analysis certifying the STREAM chlorine complies with Ghana Standard 186 on available chlorine content.

Abbreviations: FDA, Food and Drug Authority; GHS, Ghana Health Service; ICD, Institutional Care Division.

Ethiopia

The STREAM project's experience in Ethiopia highlights the importance of generating national, regional, and woreda-level ownership at the project outset and the need for flexibility. PATH's steady progress toward securing launching an evaluation of 10 STREAM devices in 10 Amhara region health facilities was put on hold due to the armed conflict that erupted in the Amhara region in May 2023. The ongoing conflict in Ethiopia's Amhara region, which has resulted in the seizure of major towns by insurgents and ongoing rural unrest, has required the project to rethink and be flexible as to where the project is implemented. Prior to the start of the conflict, PATH was able to secure approvals from the Amhara regional health bureau in May 2023 for the overall project and proposed evaluation. PATH staff met with woreda leaders and health facility administrators from the proposed health facilities to confirm their participation in the study and share information on the STREAM and study objectives.

A study protocol was prepared and approved by a Scientific Merit Committee within PATH, however final IRB approvals remain outstanding, due to the uncertainty of study locations and the fact that the Amhara public health institute who reviews and approves ethics submissions for the region is not accepting or reviewing ethics submissions at this time.

Policy and regulatory approvals for STREAM introduction in Ethiopia

April 2022	**Ethiopia Conformity Assessment Enterprise** Laboratory test report confirming the STREAM chlorine adhered to chlorine testing standards (ES 887:2002) with a result of 0.42% mg/L.
March 2023	**Amhara Regional Health Bureau** STREAM project approved by the Amhara regional health bureau, which enabled PATH to prepare and submit a STREAM protocol and study documentation to ethics review committees.
November 2023	**Ethiopia Ministry of Finance** Tax exemption granted for 20 STREAM devices for Ethiopia

Next steps

The three country examples described above illustrate how developing strong working relationships with key government leaders is critical for advancing health programs and innovations. Collaboration with health system champions led to policy approvals and regulatory certifications that are expanding the reach of the STREAM across public health systems in Ghana, Uganda, and Ethiopia. In parallel, Aqua Research continues to expand its market reach and presence, building on the experience and lessons learned in this project. Finally, PATH will continue to support government leaders, private-sector partners, and other WASH and health stakeholders through technical product and market expertise to expand the adoption of the STREAM worldwide.

For more information

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This project directly contributes to the Sustainable Development Goals 3 and 6, as well as global WASH in health care facility targets.

6 CLEAN WATER AND SANITATION

Ensure availability and sustainable management of water and sanitation for all

3 GOOD HEALTH AND WELL-BEING

Ensure healthy lives and promote well-being for all at all ages

Funding for this project was made possible by the Conrad N. Hilton Foundation.

CONRAD N. HILTON FOUNDATION

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PATH

Learning brief: Financing national adoption of the Aqua Research STREAM™ Disinfectant Generator in Uganda

February 2025

In Uganda, a health care worker uses the Aqua Research STREAM™ Disinfectant Generator, a reliable, cost-effective solution for producing chlorine. STREAM has the potential to significantly improve infection prevention and control as well as generate substantial financial savings.

Millions face preventable infections due to lack of chlorine in health care settings

Health care–acquired infections (HAIs) affect hundreds of millions of individuals worldwide and lead to significant patient treatment costs for health systems. Available data show a 28 percent HAI rate in Uganda, which is substantially high.[1] The total economic cost of HAIs in the country in 2022 was US$580 million, which equates to 1.43 percent of gross domestic product.[2] Most HAIs are preventable and can be reduced by an estimated 35 to 70 percent following effective infection prevention and control (IPC) practices.[3–5]

Chlorine is a widely used and effective chemical disinfectant recommended for IPC in health care settings. However, despite its proven effectiveness, the lack of consistent chlorine availability and quality limits the ability of health care workers to provide a safe and hygienic environment for patients. In Uganda, an analysis of chlorine stock records from ten health facilities over a year found those facilities faced an average of 74 days per year without chlorine. The primary factors that contribute to such supply gaps include weak supply chains; burdensome forecasting, procurement, and transportation processes; and insufficient budgets.[6,7] Furthermore, long exposures to sunlight and warm temperatures due to improper storage and

This document is part of the STREAM learning brief series and presents cost-effectiveness estimates and financial information to inform national adoption and scale-up of the Aqua Research STREAM™ Disinfectant Generator (STREAM) across national health care systems. Using Uganda as an example, this brief explores how the STREAM can be a financially attractive solution supporting the delivery of safe and effective infection prevention and control services.

[1] Greco D, Magombe I. Hospital acquired infections in a large north Ugandan hospital. *Journal of Preventive Medicine and Hygiene*. 2011;52(2):55–58. https://doi.org/10.15167/2421-4248/jpmh2011.52.2.250

[2] Costs of healthcare acquired infections due to inadequate water, sanitation and hygiene (WASH) in healthcare facilities in Uganda. WaterAid; 2024. https://washmatters.wateraid.org/sites/g/files/jkxoof256/files/2024-04/Costs-healthcare-acquired-infections-Uganda.pdf

[3] Schreiber PW, Sax H, Wolfensberger A, et al. The preventable proportion of healthcare-associated infections 2005–2016: systematic review and meta-analysis. *Infection Control and Hospital Epidemiology*. 2018;39:1277–1295. https://doi.org/10.1017/ice.2018.183

[4] Dancer SJ, White LF, Lamb J, et al. Measuring the effect of enhanced cleaning in a UK hospital: a prospective cross-over study. *BMC Medicine*. 2009;7. Article No. 28. https://doi.org/10.1186/1741-7015-7-28

[5] Umscheid CA, Mitchell MD, Doshi JA, et al. Estimating the proportion of healthcare-associated infections that are reasonably preventable and the related mortality and costs. *Infection Control and Hospital Epidemiology*. 2011;32(2):101–114. https://doi.org/10.1086/657912

[6] Opollo MS, Otim TC, Kizito W, et al. Infection prevention and control at Lira University Hospital, Uganda: more needs to be done. *Tropical Medicine and Infectious Disease*. 2021;6(2):69. https://doi.org/10.3390/tropicalmed6020069

[7] US Agency for International Development (USAID). Improving the Quality of Health Care Services by Strengthening IPC at Centers of Excellence: Technical Report. USAID; 2021.

transportation can lead to degradation of the chorine concentration. Finally, health care workers have reported challenges with calculating accurate dilution ratios to convert commercial chlorine solutions, which range from 1.25 mg/L to 70 mg/L, down to a 0.5 mg/L solution as recommended in IPC guidelines.

The STREAM Disinfectant Generator: An innovation for the Uganda health system

PATH and the Uganda Ministry of Health (MOH) Clinical Services Department (CSD) are collaborating to introduce the Aqua Research STREAM™ Disinfectant Generator (STREAM) into the Uganda public health system. Results from a 2019–2022 evaluation found that STREAM units could eliminate chlorine stockouts, generate a 36.9 percent cost savings over a 5-year period compared to commercial chlorine, and significantly improved IPC practices in health facilities, as reported by staff. Findings in this learning brief draw heavily from our recently published article.[8] In June 2023, the MOH Top Management Committee approved use of the STREAM in the Uganda health care system.[9] More on the device can be found here.

In parallel with these successes, PATH and MOH/CSD leaders sought to estimate the effect of on-site chlorine production using the STREAM on HAI rates and treatment costs, while also generating financial data to inform national scale-up strategies for the Uganda health care system. By addressing these challenges and providing a reliable, cost-effective chlorine supply, STREAM has the potential to significantly improve IPC and generate substantial financial savings.

Cost-effectiveness

Using a decision model, we evaluated the STREAM's potential for reducing HAI prevalence rates, HAI treatment costs, and associated disability-adjusted life years (DALYs), exploring two scenarios: (1) in which chlorine is commercially purchased at a health facility and (2) in which chlorine is produced on-site using the STREAM device. Effectiveness primarily focused on change in availability of chlorine as the result of on-site chlorine production. This was measured as a reduction in chlorine stockout days with the assumption that disinfection efforts are not effective during stockout periods. Primary data from the 2019–2023 evaluation in Uganda were used to estimate changes in chlorine stockout days at a health facility. Among the range of HAIs, we focused on surgical site infections as the most relevant condition whose infection and prevention pathways are associated with environmental cleanliness and medical equipment reprocessing/disinfection.

Use of STREAM devices across 50% of HCFs could avert 14,087 HAIs and $5,512,067 HAI treatment costs and productivity loss

Reductions in HAI incidence due to increased chlorine availability was estimated using international studies on the efficacy of chlorine and IPC. We also accounted for other risk factors for HAIs, such as non-adherence to IPC disinfection standards and quality of chlorine used for disinfection. Finally, the evaluation focused on two costs: that of chlorine production and that of HAI treatment.

Analysis shows that in Uganda, 50% of health facilities relying on a STREAM device for on-site chlorine production could generate an annual reduction of 14,087 HAIs from surgical site infections (see Table 1). Average DALYs averted equals 40,097, and the annual cost savings is estimated to be $5,512,067. Cost savings of every DALY averted range from $93 to $285.

Findings indicate the STREAM device has the potential to significantly reduce HAI and treatment costs in Uganda. The effect of STREAM use varies by health facility level, where

TABLE 1. **Cost-effectiveness estimates resulting from STREAM use in 50% of health care facilities in Uganda.**

Reduction in HAIs	Averted DALYs	DALY cost savings
SSIs potentially averted as the result of using effective IPC practices and high-quality chlorine	DALYs for every case of SSI were based on Global Burden of Disease estimates for maternal sepsis	Treatment cost savings were estimated as the averted costs associated with length of stay due to SSI multiplied by cost per inpatient day
14,087	40,097	$5,512,067

Abbreviations: DALY, disability-adjusted life year; HAI, health care–acquired infection; IPC, infection prevention and control; SSI, surgical site infection.

[8] Drolet A, Mugumya T, Hsu S, et al. Performance and acceptability of the STREAM Disinfectant Generator for infection prevention and control practices in primary health care facilities in Uganda. *Antimicrobial Resistance and Infection Control*. 2024;13(1):77. https://doi.org/10.1186/s13756-024-01433-1

[9] PATH. Learning brief: The role of government champions in national adoption of the Aqua Research STREAM™ Disinfectant Generator. PATH; 2024. https://tinyurl.com/learningbriefs

greater HAI cost savings per DALY averted are seen in health center level IVs (HCIVs) compared to district and referral hospitals. STREAM is more cost-effective for health facilities with higher chlorine demand volumes, as the up-front cost of the STREAM is outweighed by the long-term cost savings from fewer chlorine purchases.

Budgeting for national scale-up: Rationale and cost estimates

Along with understanding the potential health benefits that could result from STREAM use, we sought to calculate the financial requirements and benefits for the Uganda health system of national STREAM introduction. We compared the annual and 5-year costs of STREAM chlorine production with those of locally available commercial chlorine, determining both annual cost savings and break-even points. STREAM chlorine costs include up-front costs, such as device, shipping, taxes, and additional items (e.g., spoon, cup, bucket, jerrycans), and operational costs, including cleaning, vinegar, salt, water, and electricity. Commercial chlorine costs include chlorine and water for dilution. Large health facilities, such as regional referral and national referral hospitals, were excluded from this analysis due to their higher chlorine demand, which requires either larger-capacity chlorine generators or multiple STREAM devices, each allocated to a specific ward. Instead, the results focus on district hospitals (n = 54) and HCIVs (n = 1,094), as their chlorine demand volumes align more closely with the STREAM's production capacity. The break-even analysis identifies the point at which the accumulated cost of purchasing commercial chlorine equals the total accumulated cost of STREAM chlorine, which includes up-front and recurrent costs. Beyond this point, STREAM chlorine offers annual cost savings.

District hospitals

- **Annual district facility cost savings: $536**
- **Total savings for all districts over 5 years: $262,818**

Impact in individual district hospitals:

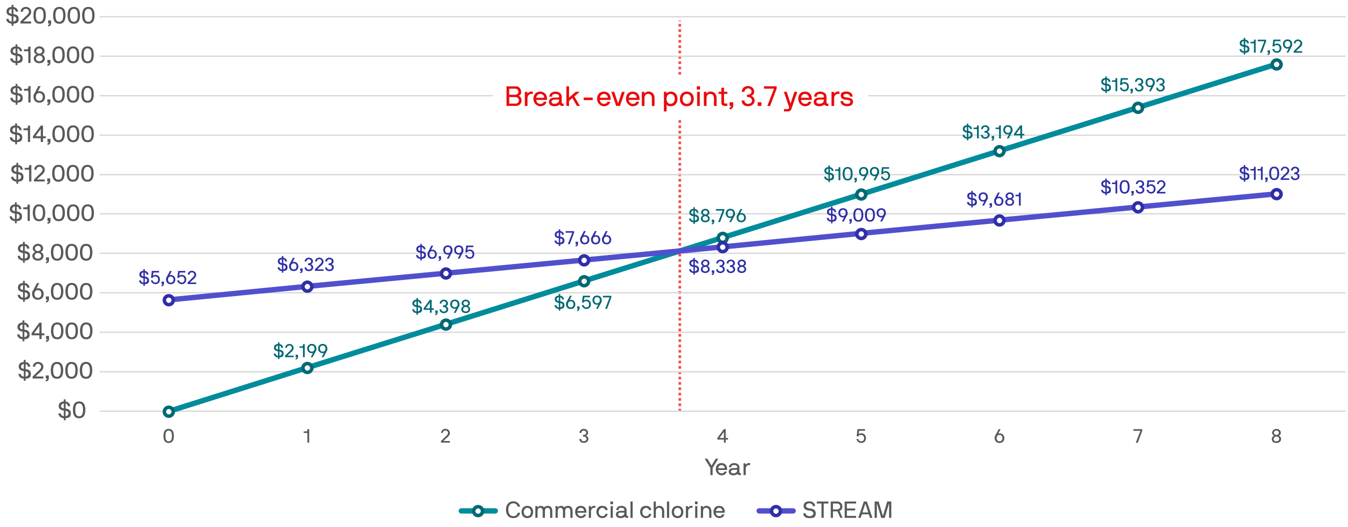
District hospitals require 13,000 liters of 0.5 mg/L chlorine solution per year, on average. To meet this demand, at least two STREAM units would need to operate for 8 hours daily. Under these assumptions, district hospitals can expect cost savings of $536 per year compared to purchasing commercial chlorine (see Table 2). Excluding the initial capital cost investment, recurrent STREAM chlorine production costs would generate even greater savings, amounting to $1,101 annually. Factoring in capital costs, the STREAM devices at district hospitals would reach the break-even point in an average of 3.7 years (see Figure 1). These savings demonstrate STREAM's potential as a cost-effective solution for district hospitals.

TABLE 2. **Chlorine costs and years to the break-even point at the district level in Uganda.**

Annual cost of commercial chlorine	Annual cost of chlorine using STREAM	Annual cost savings	Years to the break-even point
$2,199	$1,662	$536	3.7

Green: Highlights the positive financial outcomes of using the STREAM device, including the annual cost savings compared to commercial chlorine and the number of years it would take to reach the break-even point.

FIGURE 1. **Incremental cost of commercial chlorine compared to STREAM chlorine.**



Impact across all district hospitals:

At the national level, the introduction of STREAM units across all 54 district hospitals would require an up-front investment of $305,208. The recurrent annual cost is expected to average $543 per facility to produce 13,000 liters of 0.5 mg/L chlorine, compared to $2,199 for commercial chlorine procurement. This equates to $0.13 per liter for STREAM-produced chlorine, compared to $0.17 per liter for commercial chlorine. Over 5 years, the total cost savings from STREAM implementation is projected to reach $262,818 (see Table 3)—a total that would nearly cover the initial capital cost of the devices.

TABLE 3. **STREAM chlorine costs and estimated annual expenditure in Uganda hospitals.**

Annual chlorine demand per hospital	Capital cost per liter	Recurrent cost per liter	Total up-front cost	Annual recurrent cost	Total savings over 5 years
13,000 liters	$0.09	$0.0418	$305,208	$29,317	$262,818

Chlorine demand extrapolated from data reviewed from chlorine stock cards and capital costs per liter = up-front costs of STREAM amortized over 5 years and divided by the number of liters per facility. We assume that hospitals will require two STREAM devices each and health center level IVs will require one STREAM unit per facility.

Health centers

Health center levels III and IV have annual chlorine demands of 1,700 liters and 3,000 liters, respectively, but they do not currently reach the cost savings threshold for use of the STREAM device. Instead, they incur additional costs of $211 and $413 per year. However, excluding the initial capital investment, the recurrent costs would result in average annual savings of $354 for HCIIIs and $152 for HCIVs.

To improve cost-effectiveness for these facilities, adopting novel production and distribution models such as a **hub-and-spoke system** could be transformative. In this model, general hospitals or well-equipped HCIVs (hubs) produce surplus stabilized chlorine and distribute it to lower-level facilities (spokes), such as HCIIIs and other HCIVs. This approach not only reduces costs but also improves availability by reducing stockouts and logistical delays.

Breakeven within 5 years with the STREAM device: Producing at least 5,000 liters annually

For HCIVs and HCIIIs with limited chlorine demand, breakeven within 5 years is unlikely under current conditions. However, increasing production at HCIVs to more than 5,000 liters annually or adopting a hub-and-spoke model could lead to cost savings for these health facility levels. For instance, meeting the combined demand of one HCIV and two HCIIIs under this model could reach breakeven in 3.8 years, with annual recurrent costs of $325, compared to $2,743 for commercial chlorine (see Table 4).

TABLE 4. **Chlorine costs and years to the break-even point.**

Facility type	Average annual chlorine demand	Annual cost of commercial chlorine	Annual cost of chlorine using STREAM	Cost savings	Years to the break-even point
Health center hub-and-spoke model (2 HCIIIs + 1 HCIV)	6,400 liters	$2,743	$1,993	$750	3.8
HCIV	3,000 liters	$497	$709	–$211	8.2

Abbreviations: HCIII, health center level III; HCIV, health center level IV.
Green: STREAM provides cost savings when compared to commercial chlorine. Red: STREAM is more costly when compared to commercial chlorine.

Financing approaches for STREAM scale-up in Uganda

While the initial investment in STREAM is important, it is also important to carefully consider and budget for the costs of capital equipment, operation, and maintenance and repair. The STREAM device requires a one-time capital investment of $2,826. This includes the device cost plus shipping, taxes, spoon, cup, bucket, and jerrycan costs. Operating costs primarily consist of consumables, such as salt, vinegar, and jugs. These supplies are relatively inexpensive and can be sourced locally.

In 2025, PATH and the MOH/CSD will use existing data and results from an upcoming STREAM evaluation across an additional 19 health facilities to generate a total cost of ownership analysis that incorporates maintenance, repair, and spare parts into the overall costing calculation. The costing tool, break-even analysis, total cost of ownership, and cost-effectiveness models are available upon request.

For more information

Contact: Adam Drolet, PATH Product Manager, adrolet@path.org.

This project directly contributes to the Sustainable Development Goals 3 and 6, as well as global WASH in health care facility targets.

6 CLEAN WATER AND SANITATION

Ensure availability and sustainable management of water and sanitation for all

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INTRODUCTION OF A NOVEL CHLORINE GENERATOR IN GHANA, UGANDA, AND ETHIOPIA HEALTH SYSTEMS

Learning brief: Financing national adoption of the Aqua Research STREAM™ Disinfectant Generator in Ghana

September 2025

STREAM devices and supplies heading to Ghana health centers for installation, training, and monitoring.

This document is part of the STREAM learning brief series and presents cost-effectiveness estimates and financial information to inform national adoption and scale-up of the Aqua Research STREAM™ Disinfectant Generator (STREAM) across national health care systems. Using Ghana as an example, this brief explores how the STREAM can be a financially attractive solution supporting the delivery of safe and effective infection prevention and control services.

Millions face preventable infections due to lack of chlorine in health care settings

Health care–associated infections (HAIs) affect hundreds of millions of individuals worldwide and lead to significant patient treatment costs for health systems. Available data show a 12.6% HAI rate in Ghana, which is substantially high.[1] The total economic cost of HAIs in the country in 2022 was US$1.57 billion, which equates to 1.98% of gross domestic product.[2] Most HAIs are preventable and can be reduced by an estimated 35% to 70% following effective infection prevention and control (IPC) practices.[3–5]

Chlorine is a widely used and effective chemical disinfectant recommended for IPC in health care settings. However, despite its proven effectiveness, the lack of consistent chlorine availability and quality limit the ability of health care workers to provide a safe and hygienic environment for patients. In Ghana, an analysis of chlorine stock records from 12 health facilities over a year found those facilities faced an average of 65 days per year without chlorine. The primary factors that contribute to such supply gaps include weak supply chains; burdensome forecasting, procurement, and transportation processes; and insufficient budgets.[6–8] Furthermore, long exposures to sunlight and warm temperatures

[1] Fenny AP, Asante FA, Otieku E, et al. Attributable cost and extra length of stay of surgical site infection at a Ghanaian teaching hospital. *Infection Prevention in Practice*. 2020;2(2). Article No. 100045. https://doi.org/10.1016/j.infpip.2020.100045

[2] WaterAid. *Costs of Healthcare Acquired Infections Due to Inadequate Water, Sanitation and Hygiene (WASH) in Healthcare Facilities in Ghana*. WaterAid; 2024. https://washmatters.wateraid.org/sites/g/files/jkxoof256/files/2024-04/Costs-healthcare-acquired-infections-Ghana.pdf

[3] Schreiber PW, Sax H, Wolfensberger A, et al. The preventable proportion of healthcare-associated infections 2005–2016: systematic review and meta-analysis. *Infection Control and Hospital Epidemiology*. 2018;39:1277–1295. https://doi.org/10.1017/ice.2018.183

[4] Dancer SJ, White LF, Lamb J, et al. Measuring the effect of enhanced cleaning in a UK hospital: a prospective cross-over study. *BMC Medicine*. 2009;7. Article No. 28. https://doi.org/10.1186/1741-7015-7-28

[5] Umscheid CA, Mitchell MD, Doshi JA, et al. Estimating the proportion of healthcare-associated infections that are reasonably preventable and the related mortality and costs. *Infection Control and Hospital Epidemiology*. 2011;32(2):101–114. https://doi.org/10.1086/657912

[6] Opollo MS, Otim TC, Kizito W, et al. Infection prevention and control at Lira University Hospital, Uganda: more needs to be done. *Tropical Medicine and Infectious Disease*. 2021;6(2):69. https://doi.org/10.3390/tropicalmed6020069

[7] US Agency for International Development (USAID). *Improving the Quality of Health Care Services by Strengthening IPC at Centers of Excellence: Technical Report*. USAID; 2021. https://web.archive.org/web/20240718072132/https://pdf.usaid.gov/pdf_docs/PA00ZZJH.pdf

[8] Drolet A. Global community of practice (CoP) on decentralized chlorine production. PATH; 2021. https://washinhcf.org/wp-content/uploads/2022/06/Global-onsite-chlorine-generation-CoP_PPT_18AUG2021.pdf

due to improper storage and transportation can lead to degradation of the chorine concentration. Finally, health care workers have reported challenges with calculating accurate dilution ratios to convert commercial chlorine solutions, which range from 3.5 mg/L to 12 mg/L, down to a 0.5 mg/L solution as recommended in IPC guidelines.

The STREAM Disinfectant Generator: An innovation for the Ghana health system

PATH and the Ghana Health Service (GHS) are collaborating to introduce the Aqua Research STREAM™ Disinfectant Generator (STREAM) into the Ghana public health system. Results from a 2019–2022 observational study found that STREAM units could eliminate chlorine stockouts, generate a 36% cost savings at district hospitals over a 5-year period compared to commercial chlorine, and significantly improve IPC practices in health facilities, as reported by staff. From June through December 2023, PATH and Ghana Health Service's Institutional Care Division (GHS/ICD) launched a second pilot to evaluate 18 STREAM devices across 12 health facilities in Central, Ahafo, and Volta Regions. The study objectives included (1) assess changes in chlorine availability and quality; (2) validate reliability of the STREAM system using a mean time between failures approach; and (3) model the STREAM's total cost of ownership compared with commercial chlorine costs.

Key findings showed improvements in chlorine availability and quality, strong reliability, and potential cost savings.

Availability and quality: Analysis of chlorine stock cards indicated health facilities experienced an average of 37 days per year without chlorine. Health centers (n=7) faced longer stockout periods—nearly five times as long (56 versus 11 days) and twice as often per year—as compared to district hospitals (n=5). Chlorine quality analysis revealed that 83% (n=10) of facilities were using degraded chlorine. The degraded chlorine samples contained an average of 53% of their stated chlorine content (mg/L). Baseline samples from all 18 STREAM units (100%) fell within the device's target range of 5,000 ± 1,000 mg/L concentration.

Half of the health facilities using STREAM devices saw an increase in chlorine availability by an average of 763 liters per month. Lower chlorine production in the remaining facilities was due to the STREAM's production capacity limit, functionality issues, and user challenges with forecasting STREAM chlorine production volume.

Reliability: A total of 67% (n=12) of STREAM units functioned without failure. Six devices (33%) experienced one component failure and averaged 60.8 days before the failure (range 16–96 days). No devices experienced more than one component failure. The mean time to component replacement was 8 days (range 1–24 days). Overall, STREAM units remained functional for nearly 95% of the study period. All failed components were replaced and all devices were functional at the study conclusion.

Cost: Modeling indicated that 5-year STREAM total cost of ownership would range from $3,000 to $5,000. District hospitals would see a 17% savings in chlorine supply costs, and health centers would see a 48% cost increase. Comparing ongoing STREAM and commercial chlorine consumables costs, STREAM use would lead to significant cost savings: between 64% and 83%. In June 2024, the GHS issued a tender for 400 STREAM units for the country, based in part on these study findings.[9] More on the device can be found here.

In parallel with these successes, PATH and GHS leaders sought to estimate the effect of on-site STREAM chlorine production on HAI rates and treatment costs, while also generating financial data to inform national scale-up strategies for Ghana's health care system. By addressing these challenges and providing a reliable, cost-effective chlorine supply, STREAM has the potential to significantly improve IPC and generate substantial financial savings.

Cost-effectiveness

Using a decision model, we evaluated the STREAM's potential for reducing HAI prevalence rates, HAI treatment costs, and associated disability-adjusted life years (DALYs), exploring two scenarios: (1) in which a facility uses commercially purchased chlorine and (2) in which a facility produces chlorine on-site using the STREAM device. Effectiveness primarily focused on change in availability of chlorine as the result of on-site chlorine production. This was measured as a reduction in chlorine stockout days with the assumption that disinfection efforts are not effective during stockout periods. Primary data from a 2019–2023 evaluation in Ghana were used to estimate changes in chlorine stockout days at a health facility. Among the range of HAIs, we focused on surgical site infections as the most relevant condition whose infection and prevention pathways are associated with environmental cleanliness and medical equipment reprocessing/disinfection. Reductions in HAI incidence due to increased chlorine availability was estimated using international studies on the efficacy of chlorine and IPC. We also accounted for other risk factors for HAIs, such as nonadherence to IPC disinfection standards and quality of chlorine used for disinfection. Finally, the evaluation focused on two costs: that of chlorine production and that of HAI treatment.

In Ghana, district hospitals using the STREAM disinfectant generator could avert 972,185 health care–associated infections and save $90.9 million in treatment costs and productivity loss.

Analysis showed that in Ghana, all district hospitals relying on a STREAM device for on-site chlorine production could generate an annual reduction of 972,185 HAIs from surgical site infections (see Table 1). Average DALYs averted equaled 44,149, and the annual cost savings was estimated to be $90,872,049. Cost savings of every DALY averted ranged from $795 to $3,917.

[9] PATH. Learning brief: The role of government champions in national adoption of the Aqua Research STREAM™ Disinfectant Generator. PATH; 2024. https://tinyurl.com/6fvf7uew

TABLE 1. **Cost-effectiveness estimates resulting from STREAM use in all district hospitals in Ghana.**

Reduction in HAIs	Averted DALYs	DALY cost savings
SSIs potentially averted as the result of using effective IPC practices and high-quality chlorine	DALYs for every case of SSI were based on Global Burden of Disease estimates for maternal sepsis	Treatment cost savings were estimated as the averted costs associated with length of stay due to SSI multiplied by cost per inpatient day
972,185	44,149	$90,872,049

Abbreviations: DALY, disability-adjusted life year; HAI, health care–associated infection; IPC, infection prevention and control; SSI, surgical site infection.

Findings indicate the STREAM device has the potential to significantly reduce HAI and treatment costs in Ghana. STREAM is more cost-effective for health facilities with higher chlorine demand volumes, as the up-front cost of the STREAM is outweighed by the long-term cost savings from fewer chlorine purchases.

Budgeting for national scale-up: Rationale and cost estimates

Along with understanding the potential health benefits that could result from STREAM use, we sought to calculate the financial requirements and benefits for the Ghana health system of national STREAM introduction. We compared the annual and 5-year costs of STREAM chlorine production with those of locally available commercial chlorine, determining both annual cost savings and break-even points. STREAM chlorine costs include up-front costs, such as device, shipping, taxes, and additional items (e.g., spoon, cup, bucket, jerrycans), and operational costs, including cleaning, vinegar, salt, water, and electricity. Commercial chlorine costs include chlorine and water for dilution. Large facilities, such as regional and national referral hospitals, were excluded from this analysis due to their higher chlorine demand, which requires either larger-capacity chlorine generators or multiple STREAM devices, each allocated to a specific ward. Instead, the results focus on district hospitals (n=163), polyclinics (n=66), and health centers (n=1,148), as their chlorine demand volumes align more closely with the STREAM's production capacity. The break-even analysis identifies the point at which the accumulated cost of purchasing commercial chlorine equals the total accumulated cost of STREAM chlorine, which includes up-front and recurrent costs. Beyond this point, STREAM chlorine offers annual cost savings.

District hospitals

- **Annual district facility cost savings: $732**
- **Total savings for all district hospitals across the country over 5 years: $596,015**

Impact in individual district hospitals:

District hospitals require 40,000 liters of 0.5 mg/L chlorine solution per year, on average. To meet this demand, two STREAM units would need to operate for 8 hours daily. Under these assumptions, district hospitals can expect cost savings of $732 per year compared to purchasing commercial chlorine (see Table 2). Excluding the initial capital cost investment, recurrent STREAM chlorine production costs would generate even greater savings, amounting to $1,905 annually. Factoring in capital costs, the STREAM devices at district hospitals would reach the break-even point in an average of 3.1 years. These savings demonstrate STREAM's potential as a cost-effective solution for district hospitals.

TABLE 2. **Chlorine costs and years to the break-even point at the district level in Ghana.**

Annual cost of commercial chlorine	Annual cost of chlorine using STREAM	Annual cost savings	Years to the break-even point
$2,442	$1,710	$732	3.1

Green: Highlights the positive financial outcomes of using the STREAM device, including the annual cost savings compared to commercial chlorine and the number of years it would take to reach the break-even point.

Impact across all district hospitals:

At the national level, the introduction of STREAM units across all 163 district hospitals would require an up-front investment of $963,410. The recurrent annual cost is expected to average $537 per facility to produce 40,000 liters of 0.5 mg/L chlorine, compared to $2,442 for commercial chlorine procurement. This equates to $0.04 per liter for STREAM-produced chlorine, compared to $0.06 per liter for commercial chlorine. Over 5 years, the total cost savings from STREAM implementation is projected to reach $596,015 (see Table 3).

TABLE 3. **STREAM chlorine costs and estimated annual expenditure in Ghana district hospitals.**

Annual chlorine demand per hospital	Capital cost per liter	Recurrent cost per liter	Total up-front cost	Annual recurrent cost	Total savings over 5 years
40,000 liters	$0.0296	$0.0134	$963,410	$87,493	$596,015

Chlorine demand extrapolated from data reviewed from chlorine stock cards and capital costs per liter = up-front costs of STREAM amortized over 5 years and divided by the number of liters per facility. We assume that hospitals will require two STREAM devices each and health centers will require one STREAM unit per facility.

Polyclinics and health centers

Polyclinics and health centers have annual chlorine demands of 10,200 liters and 7,000 liters, respectively. Polyclinics would reach breakeven in 4.3 years and achieve annual cost savings of $90. Health centers would incur additional costs of $314 per year. Excluding the initial capital investment, recurrent costs alone would result in average annual savings of $677 for polyclinics and $273 for health centers.

Health center hub-and-spoke would break even in 3.2 years producing ~14,000 liters/year of 0.5% STREAM chlorine.

To improve cost-effectiveness for these facilities, adopting novel production and distribution models such as a **hub-and-spoke system** could be transformative. In this model, polyclinics or well-equipped health centers (hubs) produce surplus stabilized chlorine and distribute it to other facilities (spokes). This approach would not only reduce costs but also improve availability by reducing stockouts and logistical delays.

For health centers with limited chlorine demand, breakeven within 5 years is unlikely under current conditions. However, increasing production at health centers to more than 9,030 liters annually or adopting a hub-and-spoke model could lead to cost savings for these health facilities. For instance, meeting the combined demand of two health centers under this model could result in breakeven in 3.2 years, with annual recurrent costs of $189, compared to $1,123 for commercial chlorine (see Table 4).

TABLE 4. **Chlorine costs and years to the break-even point.**

Facility type	Average annual chlorine demand	Annual cost of commercial chlorine	Annual cost of chlorine using STREAM	Cost savings	Years to the break-even point
Health center hub-and-spoke model (2 health centers)	14,000 liters	$1,123	$776	$347	3.2
Health center	7,000 liters	$370	$684	–$314	10.8

Green: STREAM provides cost savings when compared to commercial chlorine. **Red:** STREAM is more costly when compared to commercial chlorine.

Next steps: Financing approaches for STREAM scale-up in Ghana

While the initial investment in STREAM is important, it is also important to carefully consider and budget for the costs of capital equipment, operation, and maintenance and repair. The STREAM device requires a one-time capital investment of $2,955. This includes the device cost plus shipping, taxes, spoon, cup, bucket, and jerrycan costs. Operating costs primarily consist of consumables, such as salt, vinegar, water, and electricity. These supplies are relatively inexpensive and can be sourced locally.

PATH and the GHS/ICD are piloting STREAM hub-and-spoke evaluations across an additional 25 health facilities to generate a total cost of ownership analysis that incorporates maintenance, repair, spare parts, and chlorine transportation into the overall costing calculation. The costing tool, break-even analysis, total cost of ownership, and cost-effectiveness models are available upon request.

For more information

Contact: Adam Drolet, PATH Product Manager, adrolet@path.org.

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INTRODUCTION OF A NOVEL CHLORINE GENERATOR
IN GHANA, UGANDA, AND ETHIOPIA HEALTH SYSTEMS

Learning brief: Building capacity of health staff across the health system in operation and maintenance of the Aqua Research STREAM™ Disinfectant Generator

PATH

July 2025

Aqua Research STREAM device operator observing the device while it produces hypochlorite disinfectant.

Background

The Aqua Research STREAM™ Disinfectant Generator is an on-site electrolytic chlorine generator designed specifically for low-resource settings. It produces a consistent flow of 0.5 percent (5,000 milligrams per liter) chlorine solution using salt, water, and electricity. The chlorine solution can be used to disinfect surfaces and medical equipment, supporting infection prevention and control (IPC) practices and preventing the spread of health care–associated infections (HAIs).

HAIs pose a significant threat globally, disproportionately affecting vulnerable populations such as mothers and newborns in low- and middle-income countries. In Ethiopia, a systematic review indicated a pooled HAI prevalence of 16.96 percent.[1] Sepsis, a consequence of these infections, contributed to over 33 percent of neonatal deaths[2] and 14.68 percent of maternal deaths.[3] Similarly, Ghana faces a substantial burden, with inpatient HAI rates averaging 8.2 percent,[4] with sepsis contributing to maternal and neonatal mortality. Uganda also experiences a high HAI burden, estimated at 28 percent of patients, further exacerbating maternal (10 percent)[5] and newborn (18 percent)[6] deaths linked to sepsis. Most of these reported HAIs are preventable.

This document is part of the STREAM learning brief series and focuses on training and capacity-building approaches for health staff to support the national adoption and scale-up of the Aqua Research STREAM™ Disinfectant Generator (STREAM) across national health care systems. This brief reflects key lessons learned from the implementation of STREAM in Ethiopia, Ghana, and Uganda. It serves as a guide for national and subnational health staff seeking to effectively implement and use the STREAM device to strengthen infection prevention and control practices. By equipping health care workers with the knowledge and skills necessary to operate and maintain the STREAM, facilities can increase its long-term impact and sustainability.

[1] Alemu AY, Endalamaw A, Belay DM, Mekonen DK, Birhan BM, Bayih WA. Healthcare-associated infection and its determinants in Ethiopia: a systematic review and meta-analysis. *PLOS One*. 2020;15(10):e0241073. https://doi.org/10.1371/journal.pone.0241073

[2] Ali MM, Kwatra G, Mengistu M, et al. Trends of neonatal sepsis and its etiology at Hawassa, Ethiopia: a five year retrospective cross-sectional study. *BMC Pediatrics*. 2025;25(1):152. doi:10.1186/s12887-025-05515-w

[3] Mekonnen W, Gebremariam A. Causes of maternal death in Ethiopia between 1990 and 2016: systematic review with meta-analysis. *Ethiopian Journal of Health Development*. 2018;32(4). https://www.ajol.info/index.php/ejhd/article/view/182583

[4] Labi AK, Obeng-Nkrumah N, Owusu E, et al. Multi-centre point-prevalence survey of hospital-acquired infections in Ghana. *Journal of Hospital Infection*. 2019;101(1):60–68. https://doi.org/10.1016/j.jhin.2018.04.019

[5] Countdown to 2030 Uganda. The Countdown profiles: A tool for action. Accessed July 21, 2025. https://data.unicef.org/countdown-2030/country/Uganda/1/

[6] United Nations Children's Fund (UNICEF). *Maternal and Newborn Health Disparities Uganda*. UNICEF; 2015. https://data.unicef.org/wp-content/uploads/country_profiles/Uganda/country%20profile_UGA.pdf

One factor contributing to these high infection rates is the inconsistent availability of chlorine, which is recommended for IPC.

The introduction of the STREAM into health care facilities in Ethiopia, Ghana, and Uganda can strengthen IPC practices in district facilities and health centers that have access to water and electricity by improving the availability of chlorine for these practices.[7] However, as with any health intervention[8] its introduction should not be a standalone solution. Through a systems-based approach[9] that addresses activities related to installation, operation, maintenance, and long-term sustainability, along with a comprehensive IPC training program and capacity, the introduction, adoption, and scale of the STREAM can greatly contribute to improved public health outcomes. This approach provides health care workers and biomedical engineers with the necessary tools and skills to implement water, sanitation, and hygiene (WASH) practices, contributing to a reduction in HAIs and improved public health.

Installation and operation

Strategic site preparation

Site preparation for STREAM device installation involves selecting appropriate health facilities that meet multiple criteria. The following should be considered: history of chlorine stockouts and variable or insufficient chlorine stock volumes (evidenced by documented records or verbal feedback from staff), average chlorine demand volumes of 400 to 800 liters of 0.5 milligrams per liter per month (to ensure sufficient chlorine coverage), access to on-site water and energy sources (mains or solar), and commitment by health administration and staff to use STREAM chlorine supply. Districts with high IPC and WASH service gaps identified through national surveys should be prioritized.

Within health facilities, selecting an appropriate location for the STREAM device should be based on several criteria: access to a reliable electricity source, proximity to a water source, presence of a wet area to manage spillage, and a central, secure location—especially near critical wards such as labor units, operating theaters, and other areas relying heavily on chlorine for disinfection. In short, health facility administrators and in-charge nurses should identify suitable, central, secure locations within the facility for STREAM placement.

Training recommendations

Trainers should provide two main trainings during installation: (1) a centralized training for district technicians/equipment managers/clinical engineers focusing on STREAM device maintenance, repair, troubleshooting, and technical support; and (2) on-site training for STREAM operators and chlorine users at each health facility on how to operate the device, monitor and record chlorine output, and clean, maintain, and troubleshoot the STREAM. Trainers should also ensure that operator manuals (see Operation and Maintenance Manual), troubleshooting guides (see Troubleshooting and Operator Flowchart), consumables, and monitoring forms are provided at each site. Additionally, trainers should conduct IPC mentorships in conjunction with the ministry of health and provide supportive supervision to reinforce correct cleaning procedures and integration of STREAM chlorine use. Where knowledge and skill level gaps are present, a facility-based refresher training on IPC is recommended.

Staff and stakeholder roles

STREAM installation requires the involvement of several key stakeholders, each with clearly defined roles and responsibilities:

Trainers/implementers. Lead the overall installation process and conduct operator trainings on device use, monitoring, cleaning, maintenance, and troubleshooting; provide consumables and monitoring forms; offer technical support both remotely and in person; and coordinate with district technicians and health facility staff. During our studies, PATH staff co-led trainings with Ministry of Health officials in Uganda, Ghana, and Ethiopia and collected data during monitoring visits.

Ministries of health. Collaborate with trainers in planning and executing installations; lead IPC mentorships and supportive supervision during monitoring visits; participate in training sessions; provide guidance and feedback throughout implementation; and support long-term integration and ownership of STREAM operational needs.

Health facility administrators and in-charge nurses. Identify appropriate locations for STREAM devices within facilities based on criteria such as electricity and water access; select primary device operators; ensure commitment and adherence of health staff to using STREAM chlorine; and support ongoing use and integration into IPC practices.

STREAM operators and chlorine users. Attend trainings on operating, monitoring, maintaining, and troubleshooting the STREAM device; generate chlorine daily; complete monitoring forms; and communicate any issues to STREAM device technicians.

Biomedical engineers and technicians. Attend centralized training on STREAM operation, maintenance, repair, and troubleshooting; provide technical support to health facilities either remotely or through site visits; set up a WhatsApp group for sharing knowledge and resolving issues alongside implementers, the ministry of health, and Aqua Research representatives; and liaise with in-country

[7] Drolet A, Mugumya T, Hsu S, et al. Performance and acceptability of the STREAM Disinfectant Generator for infection prevention and control practices in primary health care facilities in Uganda. *Antimicrobial Resistance and Infection Control.* 2024;13(1):77. https://doi.org/10.1186/s13756-024-01433-1

[8] Diaconu K, Chen Y-F, Cummins C, Jimenez Moyao G, Manaseki-Holland S, Lilford R. Methods for medical device and equipment procurement and prioritization within low- and middle-income countries: findings of a systematic literature review. *Globalization and Health.* 2017;13(1):59. https://doi.org/10.1186/s12992-017-0280-2

[9] United Nations UN Water. SDG 6 Global Acceleration Framework. Accessed July 7, 2025. https://www.unwater.org/our-work/sdg-6-global-acceleration-framework

STREAM distributors and Aqua Research to address technical support needs and provide spare parts.

Aqua Research. Provide technical guidance and support as needed, especially for complex repairs or device analysis, and name of contact for troubleshooting.

In our three implementation countries (Ethiopia, Ghana, and Uganda), PATH worked with the ministries of health and facility staff to finalize device placement across regions and within health facilities, installed one or two STREAM units depending on chlorine demand, and ensured sites were ready for operation. PATH and ministry of health counterparts also conducted operator trainings, provided consumables and monitoring forms, and established workflows for chlorine production and use. Facility staff committed to using STREAM chlorine and maintaining backup chlorine stocks. Coordination with technicians for ongoing maintenance support was also arranged.

Case studies: Installation approaches in Ghana and Uganda health facilities

In Uganda, site preparation included selecting health facilities—general hospitals and health center IVs—that aligned with the STREAM's chlorine production capacity and demand levels, as recommended by Uganda's National Advisory Committee on Medical Equipment. Facilities had to have documented commercial chlorine stock records showing at least one stockout period of 24 hours or more in the past year, reflecting local supply challenges. The selection also prioritized districts and facilities with preexisting WASH support structures identified through national surveys (e.g., UNICEF/Ministry of Water and Environment WASH survey) indicating low environmental cleanliness scores and high IPC needs. Additionally, installation planning involved coordination with Uganda's Ministry of Health Clinical Services Department and district health management teams to ensure alignment with national IPC guidelines and integration into existing health system workflows. Commitment from local hospital administrators and staff was emphasized to address contextual operational realities and promote sustained use within Uganda's public health system.

Similarly in Ghana, health facility selection was done after a validation visit to several identified facilities. The validation conducted in collaboration with national and regional Ghana Health Service leadership focused on selecting facilities based on their chlorine consumption records, existing IPC structures and their effectiveness, suitability of their infrastructure, and past record of commitment of facility management to integrate new initiatives and innovations into their operations. Above all, facilities were selected based on their need for consistent chlorine supply for their IPC practices.

Installation considerations: Human resources and health facility infrastructure

The introduction of the STREAM device has introduced new human resource demands, with users reporting increased workload due to device operation, troubleshooting, frequent cleaning, and the management of chlorine production timelines, potentially increasing staff burden. To proactively address these issues, it is important to train multiple primary users at each health facility, and some facilities design rosters for primary users so there is always someone available to operate the device. This includes involving all relevant health staff to raise awareness about the STREAM and the advantages of its chlorine, talking about and promoting proper chlorine dilution practices, and highlighting common issues with commercial chlorine quality to encourage the use of STREAM chlorine. Additionally, generating facility-level demand by engaging hospital administrators, in-charge nurses, and chlorine users helps integrate STREAM chlorine as the primary disinfectant, ensuring consistent production and use aligned with IPC goals.

Local conditions should be carefully considered prior to the installation process. These include:

Water quality. High calcium and magnesium contents in local water sources can cause technical problems, such as rapid scaling and leaks in reaction chambers. Therefore, STREAM deployments should include water hardness testing and may need to incorporate pretreatment solutions, such as reverse osmosis systems, to address mineral content. For facilities with high calcium content, rainwater is recommended as the best source of water.

Power stability. Unstable electricity can lead to power surges. While the STREAM includes a 10,000-volt surge protector, additional protection should be integrated into installation sites, and implementers should prioritize access to more reliable power sources or consider backup power options at the facility, such as solar power systems.

Transportation. Difficulties in delivering the STREAM device and its consumables (e.g., salt, vinegar) and replacement parts to remote health facilities due to poor road infrastructure, long distances, and potential logistical delays can hinder installation, maintenance, and continuous operation. Leveraging local markets and in-country STREAM technical staff for consumables and spare parts offers effective options for continued STREAM use.

Integration with infection prevention and control

Ministry of health officials and district IPC focal persons should concurrently conduct on-site IPC mentorships and supportive supervision at both intervention and control facilities during monitoring visits. These mentorships and the supportive supervision should focus on addressing identified IPC gaps and include practical demonstrations of standard cleaning procedures using chlorine disinfectants as well as on-the-job coaching. Trainers should emphasize the use of STREAM-generated chlorine as the primary disinfectant in these trainings, ensuring that health workers understand both the operation of the device and proper disinfection practices. This approach helps to reinforce correct chlorine use, improve adherence to IPC guidelines, and support sustainable improvements in health care facility hygiene.

The following examples highlight governmental efforts and collaborative initiatives in Ethiopia, Ghana, and Uganda to improve IPC and WASH services in support of the STREAM.

An assessment covering the eight World Health Organization IPC core components found significant gaps in IPC education and training levels among Ugandan health staff and in supervision, monitoring, and auditing of IPC practices, along with inadequate HAI surveillance systems.[10,11] To address this, the Ugandan government has made substantial commitments to improving IPC and WASH services in health facilities across the country. Examples include the development and release of the *Uganda National Infection Prevention and Control Guidelines 2013*; efforts to strengthen IPC education, training, supervision, monitoring, and auditing practices among health staff; and initiatives to improve HAI surveillance systems and training programs connected to their health services aimed at reducing infectious diseases.

The Ghana Health Service and other agencies of the Ministry of Health have made significant efforts to improve the quality of WASH services, including IPC training.[4,12] The Ghana Health Service's recent 2024 to 2028 national strategy provides updated guidelines to boost IPC capabilities, monitoring, and the tracking of HAIs nationwide.[13] Furthermore, the National Healthcare Quality Strategy from 2017 to 2021 highlights the importance of consistently having IPC resources, equipment, and necessary WASH infrastructure in health care settings.[14,15] The national IPC/WASH Taskforce, established in 2016, has been crucial in making professional training and skills development for health workers standard practice.

However, challenges persist; a review of IPC preparedness in 56 Ghanaian health facilities revealed considerable shortcomings, including a lack of clear IPC goals, inadequate funding, inconsistent required training, and limited availability of vital IPC supplies.[16]

The Ethiopia Ministry of Health recognizes the importance IPC plays in preventing HAIs, as evidenced by its national infection control policy.[17] The Ethiopian government, through the Ministry of Health, Addis Ababa City Administration Health Bureau, and Amhara Regional Health Bureau, plays a collaborative role in strengthening IPC efforts. They partner with organizations like PATH and Millennium Water Alliance to introduce and assess on-site chlorine generation technology (e.g., STREAM) in health care facilities. The government is involved in providing IPC training facilitated by Ministry of Health experts, supporting project implementation in selected health centers and woredas, and contributing personnel for training workshops. Their engagement aligns with national WASH strategies and IPC guidelines aimed at improving health care quality and patient safety across the country.

Within these programs, PATH and the ministries of health have integrated the STREAM using capacity-building approaches to support the effective use and maintenance of the STREAM. According to the staff member in charge of the maternity ward at Masindi General Hospital in Uganda, "The cases of sepsis at postnatal ward has greatly reduced because we now pour out the chlorine once it changes color since we have enough chlorine, unlike before when we only disinfect a few areas because we have very limited volume of Jik [chlorine]."

Maintenance and repair

The biomedical engineer (or the designated technical point of contact for maintenance) should be present during the STREAM training sessions. This role involves being the technical expert responsible for the maintenance and troubleshooting of the STREAM, ensuring its proper operation and addressing any technical issues that arise with the device.

Regional biomedical engineers should already be familiar with common mechanical and user errors, diagnostic procedures, and repairs so that they can build local technical capacity for ongoing support or receive their own training. If a device cannot be fixed on-site, backup units stored at the regional level can be deployed. Malfunctioning devices may be sent back to the manufacturer for further analysis. This minimizes downtime and ensures continuous chlorine production while building sustainable maintenance capacity locally.

For instance, in Uganda, local technicians addressed technical challenges with the STREAM devices, such as repairing leaking reaction chambers resulting from calcium scaling and pressure buildup and reinforcing poorly soldered circuit board connections with more durable replacement parts. To illustrate further, technicians in Uganda specifically replaced reaction chambers to resolve leaks, added an outer titanium plate to the cathode housing to prevent warping and subsequent leaks, upgraded circuit board socket connectors for enhanced robustness, and improved the power supply to the control box connector to a higher-rated version to prevent overheating.

Similarly, during evaluations in Ghana, local technicians successfully resolved various issues with the STREAM

[10] Uganda Ministry of Health. *National Infection Prevention and Control Survey Report*. Uganda Ministry of Health; 2019.

[11] Opollo MS, Otim TC, Kizito W, et al. Infection prevention and control at Lira University Hospital, Uganda: more needs to be done. *Tropical Medicine and Infectious Disease*. 2021;6(2):69. https://doi.org/10.3390/tropicalmed6020069

[12] Sunkwa-Mills G, Senah K, Breinholdt M, Aberese-Ak M, Tersbøl BP. A qualitative study of infection prevention and control practices in the maternal units of two Ghanaian hospitals. *Antimicrobial Resistance and Infection Control*. 2023;12(1):125. https://doi.org/10.1186/s13756-023-01330-z

[13] Ghana Ministry of Health. MOH launches National Infection Prevention and Control Strategy. Accessed March 17, 2025. https://www.moh.gov.gh/moh-launches-national-infection-prevention-and-control-strategy/

[14] Ghana Ministry of Health. *Ghana National Healthcare Quality Strategy (2017-2021)*. Ghana Ministry of Health; 2016. https://www.moh.gov.gh/wp-content/uploads/2017/06/National20Quality20Strategy20Ghana.pdf

[15] World Health Organization (WHO). *Report on the Burden of Endemic Health Care-Associated Infection Worldwide*. WHO; 2011. https://apps.who.int/iris/handle/10665/80135

[16] Oppong TB, Amponsem-Boateng C, Kyere EKD, et al. Infection prevention and control preparedness level and associated determinants in 56 acute healthcare facilities in Ghana. *Infection and Drug Resistance*. 2020;13:4263–4271. https://doi.org/10.2147/IDR.S273851

[17] Ethiopia Ministry of Health. *National Infection Prevention and Control Policy*. Ethiopia Ministry of Health; 2021. http://repository.iphce.org/bitstream/handle/123456789/1701/1_National_Infection_Prevention_and_Control_Policy_Final_Version.pdf?sequence=1&isAllowed=y

devices. Their interventions included replacing a malfunctioning controller board plagued by loose circuit connections, substituting two power supplies likely damaged by sustained high voltage despite surge protection, repairing circuit boards affected by connection problems or overheating by replacing components such as a diode and stepper board, and resolving a leaking reaction cell due to calcium scale accumulation. These repairs, involving component replacements, directly informed manufacturer enhancements such as the implementation of more secure cable connections.

Sustained use

A comprehensive socialization strategy is needed to ensure national, regional, and district staff effectively support the STREAM long term. For example, in Uganda, PATH and the Ministry of Health Clinical Services Department held meetings with district health management teams in all target districts to ensure broad awareness among relevant district staff such as technicians and IPC focal persons. Health facility administrators were provided with detailed information sheets explaining the study. Trainings for operators, chlorine users, and maintenance technicians emphasized not only technical skills but also the benefits and integration of STREAM chlorine into existing IPC practices. Ongoing communication through WhatsApp groups facilitated knowledge sharing and troubleshooting among technicians and stakeholders. These efforts helped encourage ownership, ease adoption, and support sustained use within Uganda's public health system.

In Ghana, sustained use of the STREAM has been achieved by strong collaboration between leaders of the Ghana Health Service at the national, regional, district, and health facility levels at all stages of the piloting process, including planning and executing the installation, training, and monitoring exercises. This has enabled them to take ownership of the device and ensure its sustained use. Where active monitoring has been completed, lines of communication have been established for PATH support and for procurement of consumables and parts from Aqua Research representatives in Ghana, ensuring that technical challenges are resolved in the shortest possible time.

Furthermore, establishing collaborations with parts distributors for the STREAM may involve formalizing supply agreements with Aqua Research and its regional partners or directly contacting Aqua Research to identify local authorized distributors that stock and supply replacement components.

Overall lessons learned from implementation sites

Prioritize engagement in tailored training sessions. PATH found that for effective STREAM trainings, participant engagement is important. Trainings should:

- Actively involve participants through a hands-on experiential approach where device users practice each step—from setting up the brine solution to operating and cleaning the device—to ensure they gain practical experience.
- Use varied formats that include reading and explaining steps, followed by participant practice and group review to reinforce learning.
- Ensure training content is directly relevant to each participant's specific role and context. For example, hospital administrators should identify primary users from medical store staff or cleaners, and instructions on daily chlorine production and monitoring could be tailored to health care wards such as surgery theaters and maternity units.

Emphasize real-world applications, including preparing precise brine solutions, troubleshooting common errors indicated by LED lights, and performing regular cleaning cycles to prevent scale buildup (see our best practices manual).

Pair installation and trainings with IPC refresher training for health impact. PATH has also learned that pairing the installation and training on the use of the STREAM with IPC refresher trainings goes a long way toward improving skills for device use and impacts on IPC practices. With the introduction of the STREAM, there is renewed enthusiasm for IPC, and these refresher trainings provide an opportunity to leverage this enthusiasm to build on the existing knowledge, skills, and capacity of health care staff in this regard. Key outcomes that PATH has observed are the formation or reinstatement of IPC focal persons and teams, renewed commitment of facility management to provide other needed logistics to improve IPC practices, and development of action plans and roadmaps for sustainable use of the STREAM and ensuring its full benefits are realized in improving IPC practices. Prior to conducting these refresher trainings, each facility undergoes an assessment to identify key challenges in IPC. The refresher trainings are primarily designed to focus on and address these challenges.

Resources

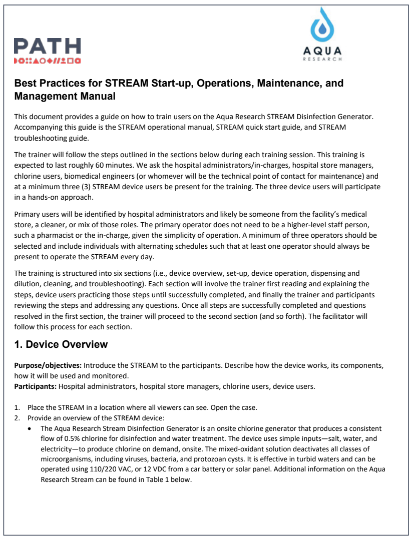
The following section provides a collection of essential resources designed to support the effective use, maintenance, and troubleshooting of the STREAM. These materials are tailored for a variety of users, including health care workers, biomedical engineers, and technicians.

Best Practices for STREAM Start-up, Operations, Maintenance, and Management Manual

Intended for hospital administrators, device users, chlorine users, and biomedical engineers responsible for operating and maintaining the STREAM, this document provides a comprehensive 60-minute training guide covering device overview, setup, start-up, shutdown/storage, cleaning, dilution, and troubleshooting. It details the device's components and function, the preparation of brine solution, power options, tubing assembly, error identification, cleaning cycles to prevent scale buildup, proper dilution for various uses, and step-by-step troubleshooting procedures. The guide emphasizes hands-on practice with at least three operators to ensure continuous daily use and includes monitoring and supply management protocols during the study period.

English: https://aquaresearch.com/wp-content/uploads/2025/07/1_Training-manual-checklist_EN.pdf

Portuguese: https://aquaresearch.com/wp-content/uploads/2025/07/2_Training-manual-checklist_PT.pdf



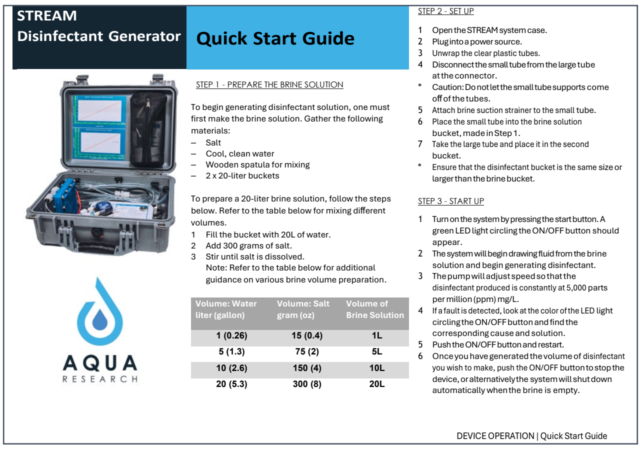
Quick Start Guide

Primarily intended for health care workers who frequently use the STREAM, this one-page guide provides step-by-step instructions for preparing and operating the device. It covers preparing the brine solution, setting up and starting the device, shutdown and storage, dilution, cleaning, and troubleshooting common problems. As it outlines the most common day-to-day tasks, it should be laminated and kept near the device for quick reference. More detailed information can be found in the operation and maintenance manual.

English: https://aquaresearch.com/wp-content/uploads/2025/07/3_Quick-start-guide_EN.pdf

Amharic: https://aquaresearch.com/wp-content/uploads/2025/07/4_Quick-start-guide_AMH.pdf

Portuguese: https://aquaresearch.com/wp-content/uploads/2025/07/5_Quick-Start-Guide_PT.pdf

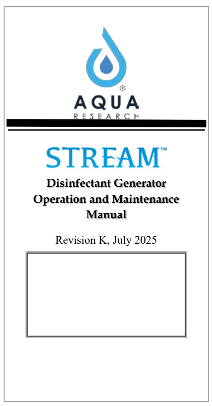


STREAM Disinfectant Generator Operation and Maintenance Manual

Intended for health care workers and users tasked with installing, operating, maintaining, or troubleshooting the STREAM, this manual provides detailed operation and maintenance instructions. It is provided with each device purchased, and it includes specifications, safety warnings, regulatory compliance information, system component descriptions, installation guidelines, start-up procedures, maintenance protocols, troubleshooting steps, and storage recommendations.

English: https://aquaresearch.com/wp-content/uploads/2025/07/6_STREAM-OM-MANUAL-AR-SMALL-VERSION-REV-K-070925_EN.pdf

Amharic: https://aquaresearch.com/wp-content/uploads/2025/07/7_STREAM-OM-MANUAL-AR-SMALL-VERSION-REV-K-071025_AMH.pdf

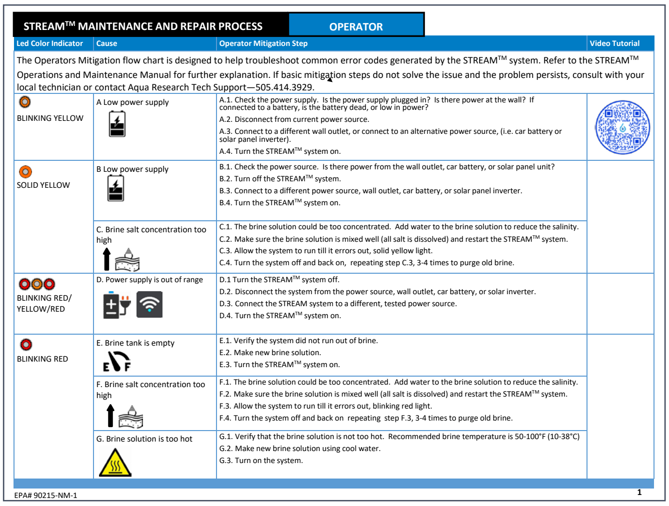


Troubleshooting and Operator Flowchart

This flowchart is designed to help troubleshoot common error codes generated by the STREAM system, providing troubleshooting steps based on LED color indicators and problem symptoms. It identifies potential causes, including power supply issues, brine salt concentration problems, clogged tubing or cells, ruptured discs, overheating, pump malfunctions, moisture leaks, low chlorine production, and calcium carbonate fouling. For each issue, the guide provides specific mitigation. More detailed guidance can be found in the STREAM operation and maintenance manual.

English: https://aquaresearch.com/wp-content/uploads/2025/07/8_TROUBLESHOOTING-OPERATOR-FLOWCHART_EN.pdf

Amharic: https://aquaresearch.com/wp-content/uploads/2025/07/9_TROUBLESHOOTING-OPERATOR-FLOWCHART_AMH.pdf


STREAM™ MAINTENANCE AND REPAIR PROCESS — OPERATOR

Led Color Indicator	Cause	Operator Mitigation Step	Video Tutorial
The Operators Mitigation flow chart is designed to help troubleshoot common error codes generated by the STREAM™ system. Refer to the STREAM™ Operations and Maintenance Manual for further explanation. If basic mitigation steps do not solve the issue and the problem persists, consult with your local technician or contact Aqua Research Tech Support—505.414.3929.			
BLINKING YELLOW	A Low power supply	A.1. Check the power supply. Is the power supply plugged in? Is there power at the wall? If connected to a battery, is the battery dead, or low in power? A.2. Disconnect from current power source. A.3. Connect to a different wall outlet, or connect to an alternative power source, (i.e. car battery or solar panel inverter). A.4. Turn the STREAM™ system on.	
SOLID YELLOW	B Low power supply	B.1. Check the power source. Is there power from the wall outlet, car battery, or solar panel unit? B.2. Turn off the STREAM™ system. B.3. Connect to a different power source, wall outlet, car battery, or solar panel inverter. B.4. Turn the STREAM™ system on.	
	C. Brine salt concentration too high	C.1. The brine solution could be too concentrated. Add water to the brine solution to reduce the salinity. C.2. Make sure the brine solution is mixed well (all salt is dissolved) and restart the STREAM™ system. C.3. Allow the system to run till it errors out, solid yellow light. C.4. Turn the system off and back on, repeating step C.3, 3-4 times to purge old brine.	
BLINKING RED/ YELLOW/RED	D. Power supply is out of range	D.1 Turn the STREAM™ system off. D.2. Disconnect the system from the power source, wall outlet, car battery, or solar inverter. D.3. Connect the STREAM system to a different, tested power source. D.4. Turn the STREAM™ system on.	
BLINKING RED	E. Brine tank is empty	E.1. Verify the system did not run out of brine. E.2. Make new brine solution. E.3. Turn the STREAM™ system on.	
	F. Brine salt concentration too high	F.1. The brine solution could be too concentrated. Add water to the brine solution to reduce the salinity. F.2. Make sure the brine solution is mixed well (all salt is dissolved) and restart the STREAM™ system. F.3. Allow the system to run till it errors out, blinking red light. F.4. Turn the system off and back on repeating step F.3, 3-4 times to purge old brine.	
	G. Brine solution is too hot	G.1. Verify that the brine solution is not too hot. Recommended brine temperature is 50-100°F (10-38°C) G.2. Make new brine solution using cool water. G.3. Turn on the system.	

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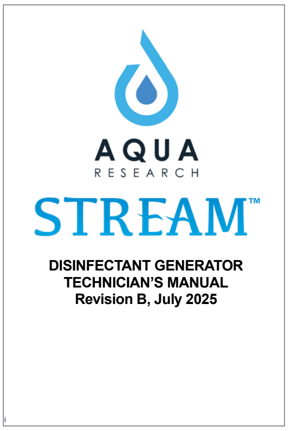
STREAM Disinfectant Generator Technician's Manual

Intended for biomedical officers and other technicians who service the STREAM, this guide offers in-depth instructions for troubleshooting and repair tasks. It covers device components, required tools, and procedures such as addressing scale formation, diagnosing voltage and current errors, resolving pump issues, and responding to low chlorine production.

English: https://aquaresearch.com/wp-content/uploads/2025/07/10_STREAM-TECHNICIANS-MANUAL-REV-B-071025_EN.pdf

Amharic: https://aquaresearch.com/wp-content/uploads/2025/07/11_STREAM-TECHNICIANS-MANUAL-REV-A-050823_AMH.pdf

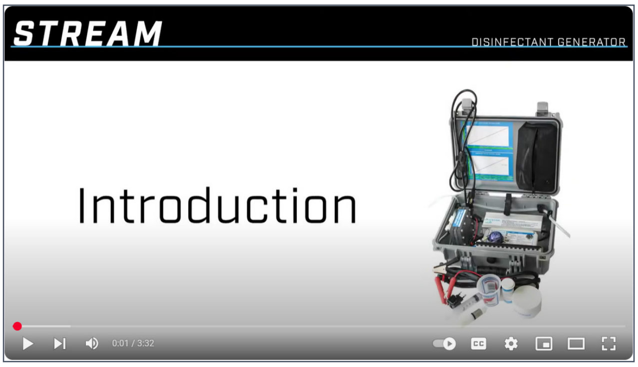


STREAM video series

This series of short videos provides an introduction to the STREAM, instructions for making the brine solution, and guidance on system start-up.

Introduction to the STREAM

English: https://youtu.be/R3Mv1QurNCw

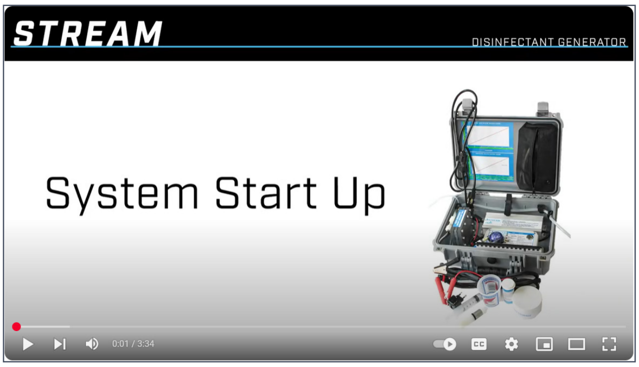


How to make the brine solution

English: https://www.youtube.com/watch?v=2nYX7K4SFIk

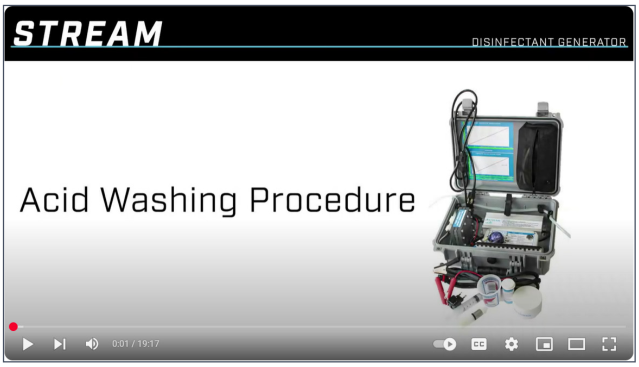
How to start up the STREAM system

English: https://www.youtube.com/watch?v=JD8EGak6NQo



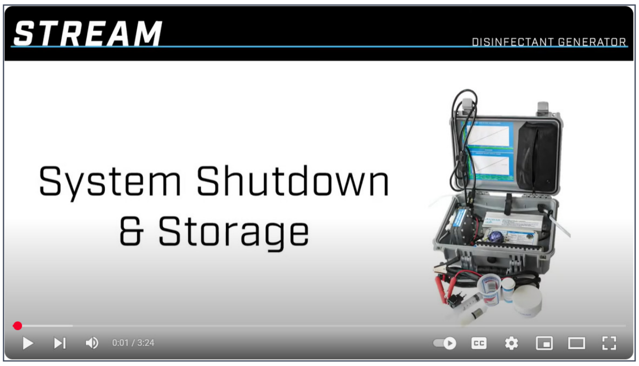
How to clean the STREAM using various acids such as vinegar or diluted muriatic acid

English: https://www.youtube.com/watch?v=Y_7lCrPHor8



How to shut down and store the STREAM

English: https://www.youtube.com/watch?v=lPxDBvWYenc



WASH FIT

Used by more than 70 countries, WASH FIT (the Water and Sanitation for Health Facility Improvement Tool) is a free digital tool developed by the World Health Organization and UNICEF to provide practical steps to help health care facilities improve and maintain their WASH services. Aimed at primary and secondary health facilities in low- and middle-income countries, the tool covers topics related to water, sanitation, hand hygiene, environmental cleaning, health care waste management, energy, and building and facility management.

English: https://www.washinhcf.org/wash-fit/

WASH FIT Home **Example** My Data

Indicators Team List Team Meetings Hazards

Water

	Indicator	Meets Target +++	Partially Meets Target ++	Does Not Meet Target +	Assessment 2016-12-14	Assessment 2017-02-08	Notes
1.1	Improved water supply piped into facility or on premises	Improved water supply within facility and available	Improved water supply on premises (outside of facility building) and available	No improved water source within facility grounds, or improved supply in place but not available			
1.2	Water services available at all times and of sufficient quantity	Water services available every day and of sufficient quantity	Water services available more than 5 days per week or every day but not sufficient quantity	Water services available fewer than 5 days per week	++	+++	Water has improved
1.3	Drinking water station available	A reliable drinking water station is present at all times and locations and accessible to all	A reliable drinking water station is present sometimes, or only in some places or not available for all users	A reliable drinking water station is not available	++	++	
1.4	Drinking water safe storage	Yes, drinking water is safely stored with cover and tap	All available drinking water points are safely stored	Drinking water points are not safely stored or no drinking water available	+++	+++	
1.6	All end points connected to functioning water supply	Yes, all end points are connected to an available and functioning water supply	More than half of all endpoints are connected to an available and functioning water supply	No, less than half of all endpoints are connected to an available and functioning water supply	+++	+++	
1.7	Water services available throughout the year	Yes, water services are available throughout the year	Water services have shortages for 1–2 months	Water services have shortages for 3 months or more	+	++	Dry season is hard
1.8	Water storage is sufficient	Yes, water storage is sufficient to meet the needs of the facility for 2 days	Water storage to meets more than 75% of the needs of the facility for 2 days	Water storage to meets less than 75% of the needs of the facility for 2 days	+	+++	
1.9	Water treatment meets WHO standards	Yes, water is treated with a proven technology that meets WHO performance standards	Water is treated but not regularly with a proven technology that meets WHO performance standards	Water is not treated with a proven technology that meets WHO performance standards	+++	+++	
1.10	Drinking water has chlorine residual	Yes, drinking water has appropriate chlorine residual or 0 E.Coli/100 ml and is not turbid	Drinking water has chlorine residual exists, but is <0.2mg/l	Drinking Water is not treated/do not know residual/do not have capacity to test residual/no drinking water available	+	+++	

For more information

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adrolet@path.org.

This project directly contributes to the Sustainable Development Goals 3 and 6, as well as global WASH in health care facility targets.

6 CLEAN WATER AND SANITATION

Ensure availability and sustainable management of water and sanitation for all

3 GOOD HEALTH AND WELL-BEING

Ensure healthy lives and promote well-being for all at all ages

Funding for this project was made possible by the Conrad N. Hilton Foundation.

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PATH is a global nonprofit dedicated to achieving health equity. With more than 40 years of experience forging multisector partnerships, and with expertise in science, economics, technology, advocacy, and dozens of other specialties, PATH develops and scales up innovative solutions to the world's most pressing health challenges.

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