Chlorine Dioxide Versus Automated Vaporized Hydrogen Peroxide for High-Level Disinfection of Ultrasound Probes in Outpatient Practice

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BACKGROUND

Ultrasound has long been considered a safe diagnostic and procedural modality; however, ultrasound probes have been well documented as potential vehicles for bacterial, viral, and fungal transmission across a variety of clinical settings. Accordingly, high-level disinfection (HLD) of semi-critical ultrasound probes is a patient safety and regulatory requirement.[1]

Automated vaporized hydrogen peroxide (H_2O_2) systems (VHP), widely implemented for probe HLD are associated with substantial capital investment and ongoing maintenance requirements. Chlorine dioxide (ClO_2) foam and wipes have been used for point-of-care ultrasound probe HLD in 35 countries since 2008[2,3], and received U.S. Food and Drug Administration (FDA) clearance in 2023[4], consistent with ANSI/AAMI ST58 standards.[5] However, published evidence describing the operational impact and real-world feasibility of manual ClO_2 foam and wipes in U.S. outpatient practice remains limited.

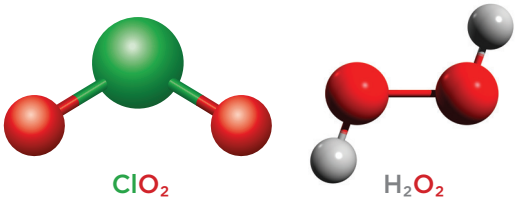
OBJECTIVE

To compare workflow and probe turnaround times between two HLD methods for ultrasound probes and assess the feasibility of ClO_2 foam and wipes implementation, including training, protocol adherence, and annual operating costs.

THE SCIENCE

ClO_2 and H_2O_2 are oxidizing agents with different antimicrobial mechanisms.

ClO_2 acts through selective oxidative disruption of essential amino acids and membrane lipids, leading to loss of protein function and membrane integrity.[6] H_2O_2 generates reactive oxygen species that produce broad, non-specific free radical damage to multiple cellular components simultaneously.[7]



ClO_2
Chlorine Dioxide

H_2O_2
Hydrogen Peroxide

High-Level Disinfection Efficacy and Antimicrobial Spectrum
Recent independent evaluation confirmed that ClO_2 foam and wipes met FDA performance criteria for high-level disinfection.[8]

Consistent with FDA-defined HLD requirements, both agents demonstrate activity against:

Mycobacteria (e.g., Mycobacterium terrae) – benchmark organism for HLD[6]; vegetative bacteria (Gram-positive and Gram-negative)[6,7]; viruses, including enveloped and non-enveloped viruses (e.g., HIV, HPV)[6,9]; fungi[5]; with additional activity against bacterial spores[8,9,10]; and stabilized ClO_2 can effectively kill spores resistant to H_2O_2 showing it can be a stronger sporicidal agent.[11]

METHODS

From October 2025 through January 2026, we conducted a quality improvement initiative evaluating the transition from automated vaporized hydrogen peroxide (VHP) (HLD) (Trophon EPR/2®; Nanosonics; Indianapolis, IN) to manual chlorine dioxide foam and wipes HLD (Tristel ULT®; Parker Labs, Fairfield, NJ) for ultrasound transducers in an outpatient urology practice.

The clinic has two exam rooms and performs approximately 200 transrectal ultrasound procedures annually. Prior to this initiative, this site used automated VHP for transducer HLD for 3 years.

Data Collection Process data included:

- **Staff adherence to the manual ClO_2 foam and wipes foam reprocessing protocol**, assessed through one-on-one, timed direct observations conducted by the study lead. A structured observation checklist aligned with the manufacturer's instructions for use (IFU) was used to document adherence.
- **Workflow steps for each HLD modality** derived from institutional policies and procedures.

Outcomes assessed included:

- **Probe turnaround time** defined as the interval from immediate post-use handling to readiness for subsequent clinical use. Measured using a timer during direct observation sessions for ClO_2 foam and wipes, and by observation of a standardized process simulation replicating routine clinical workflow (including transport and device cycle time) for automated VHP.
- **Feasibility of protocol-specific staff training for proper use of ClO_2 products**, assessed qualitatively based on training duration and observed competency.
- **Projected annual operating costs for 2026**, calculated using institutional administrative data obtained from the supply chain department and the physician specialty group.

Automated vaporized hydrogen peroxide (VHP).

Manual chlorine dioxide foam and wipes.

INTERVENTION

Staff training for ClO_2 foam and wipes use included:

- Manufacturer-provided online training (3 online videos with quiz on completion, ~15 minutes total)
- 1:1 in-person instruction and demonstration (by Infection Prevention educator)
- Direct observation of return demonstration by online certified trained staff to confirm competence and adherence with the new reprocessing protocol (~15 minutes total).
- Staff then used the product for HLD of all compatible ultrasound probes requiring HLD.

Documentation and Traceability

Documentation and traceability procedures are identical for both methods:

- All ultrasound probe reprocessing disinfectant event activities are documented in a dedicated manual logbook.
- To ensure traceability, reprocessing records are linked to the specific patient on whom the transducer was used.

RESULTS

Figure 1. Generalized Workflow for High-Level Disinfection of Ultrasound Probes in an Outpatient Urology Practice

Preparation (Both Methods)

· Remove sheath · Clean probe · Dry completely · Perform hand hygiene · Don personal protective equipment

Disinfection Steps

Automated H_2O_2 (VPH)	Manual ClO_2 Foam
Insert probe	**Activate foam on wipe (10 sec)**
Power on/Warm up device (2 min)	Apply foam to probe
Start automated cycle	Place in probe holder
~7-minute closed cycle	Set timer for **2-minute contact time**
Doff, perform hand hygiene, don new gloves	Doff, perform hand hygiene, don new gloves
Remove probe from machine and inspect for damage	Use clean wipe to remove any residue

Post-HLD Handling (Both Methods)

· Probe ready for use · Apply new probe cover · Store per manufacturer instructions

Summary

Both methods achieve high-level disinfection when manufacturer instructions are followed. The primary workflow distinction is processing duration and automation level.

A total of 10 staff members (6 registered nurses and 4 medical assistants) participated in the initiative. All participants received 15 minutes of individualized, in-person instruction followed by direct observation.

Direct observation demonstrated high adherence to the ClO_2 reprocessing protocol. Nine of 10 participants achieved competency on initial assessment; one participant required additional observation prior to demonstrating full adherence.

90% of participants applied foam properly on initial assessment.

The number and overall structure of workflow steps were comparable between methods (Figure 1).

Mean ultrasound probe turnaround time for manual ClO_2 foam was approximately 4 minutes. In contrast, the automated VHP system required approximately 14:30 minutes per cycle, inclusive of simulated transport and device processing time.

The manual foam process was integrated into routine clinical workflows without disruption to patient care during the 3-day implementation observation period.

COSTS

Projected annual operating costs for each method are shown in Table 1. Projections are based on 216 cases per year and reflect only incremental operating expenses; capital equipment and labor costs were excluded from the base-case comparison.

Table 1. Annual Operating Cost Comparison: ClO_2 Foam vs Automated (216 Cases/Year)

Category	ClO_2 Foam	Automated VHP
Annual Consumables	$1,017	$10,191
Preventive Maintenance	$0	$1,200
Compliance Monitoring (ChemDAQ)	$0	$2,195
Total Annual Operating Cost	**$1,017**	**$13,586**

Projected annual operating cost difference:
Automated VHP costs +$12,569 per year compared with ClO_2 foam

Additional capital investment (2026):
Automated VHP system and ChemDAQ monitoring: $8,000

Total projected 2026 cost difference (operating + capital): +$21,586 for automated VHP

CONCLUSION AND FUTURE DIRECTIONS

In this outpatient urology practice, manual ClO_2 foam was operationally feasible for high-level disinfection of ultrasound probes and was successfully integrated into existing clinical workflows.

Point-of-care manual HLD was associated with shorter probe turnaround times and lower projected annual costs compared with automated VHP systems, while maintaining high adherence to established reprocessing protocols. Implementation outcomes informed optimization of local policies, staff training, and documentation practices.

These data contribute to the limited literature describing the real-world operational performance of ClO_2 foam in outpatient settings in the United States. However, this evaluation was conducted at a single site over a limited observation period; therefore, findings may not be generalizable to other clinical environments.

A pilot evaluation of chlorine dioxide foam and wipes is planned in the inpatient surgical setting to further assess workflow integration, adherence, and operational impact.

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