The 4 Cs of High-Level Disinfection: Building Confidence in Ultrasound Probe Reprocessing



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Infection Prevention. For Life.

Ultrasound probes that contact mucous membranes or non-intact skin are classified as semi-critical medical devices and require cleaning followed by high-level disinfection (HLD) after every patient use.[1]

HLD, when performed under validated reprocessing conditions, is designed to completely inactivate vegetative bacteria, mycobacteria, fungi, and viruses. Bacterial spores are not reliably inactivated by HLD, although some spore reduction may occur, when present at lower spore loads.[2,3]

Ultrasound probe HLD can be performed using a range of modalities, from manual approaches such as chemical immersion and chlorine dioxide wipes to automated systems that utilise hydrogen peroxide mist or ultraviolet-C (UV-C) technology. Different HLD modalities use different mechanisms of action and have unique requirements for exposure, workflow, monitoring, occupational safety and device compatibility.[4,5]

Ultrasound probes consist of visible and microscopic complex surface topography that may harbour microorganisms and challenge some disinfection modalities.[6] Therefore, effective reprocessing depends on more than simply selecting a disinfectant. It requires consistent delivery of the critical conditions necessary for microbial inactivation: Chemistry (modality), Concentration (or dose for UV-C modality), Contact Time and Coverage - the 4 Cs of HLD.[7,8]

Effective HLD depends on consistently delivering the critical factors required for complete microbial inactivation: Chemistry (modality), Concentration (dose), Contact Time and Coverage

The disinfectant (modality) is the foundation of HLD.

An effective chemistry (modality) must provide broad-spectrum antimicrobial activity, be supported by clinical evidence and guidelines, and be compatible with ultrasound probes.[7,8]

Chemistry (modality)
Proven disinfectant performance

Microbial inactivation, depends on delivering the minimum effective concentration (or UV-C dose) of disinfectant to all required surfaces.

Variability in concentration (or UV-C dose delivered) impacts the disinfection efficacy leading to inadequate HLD[7,8]

Concentration (UV-C dose)
Minimum effective concentration or dose

The 4Cs of HLD

Coverage
Complete surface coverage

Ultrasound probes consist of complex surface topography that may harbour microorganism.[6]

Microorganisms may remain viable within these complex surface topographical features if these areas are not adequately exposed to the disinfectant.

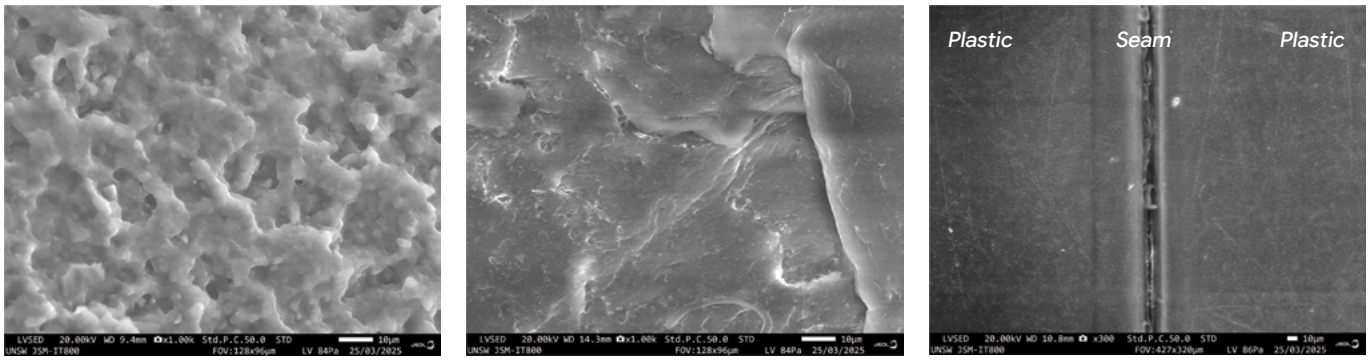
Coverage is therefore, essential to effective HLD.[6-8]

Contact time
Validated exposure period

The disinfectant must remain in contact with the probe surface for the validated exposure period.

Contact time should not begin until all required surfaces are fully exposed to the disinfectant, and interruptions or premature drying may affect the process.[7,8]

Effective disinfection depends on a disinfectant reaching the complex surface features of ultrasound probes that may harbour microorganisms.



Lens (x1000) *Surface scratch (x1000)* *Seam (x300)*

Scanning Electron Microscopy images of ultrasound probes[6]

Not all HLD modalities deliver the 4 Cs in the same way

Various disinfectants are available for HLD of ultrasound probes. However, not all will consistently deliver on the four critical factors.

For example, foam activated HLD wipes rely heavily on manual technique. Achieving complete coverage and maintaining validated contact time across all probe surfaces can be challenging, particularly on probes with complex topography.[7,20,21,27,28] The effectiveness of UV-C HLD technology depends on direct line-of-sight exposure. Surface complexity and shadowing can create areas that receive less irradiance or dose potentially resulting in inadequate disinfection.[7-9,22-26]

These workflow and technology-related limitations may make it difficult to consistently deliver all four requirements of HLD across every reprocessing cycle.

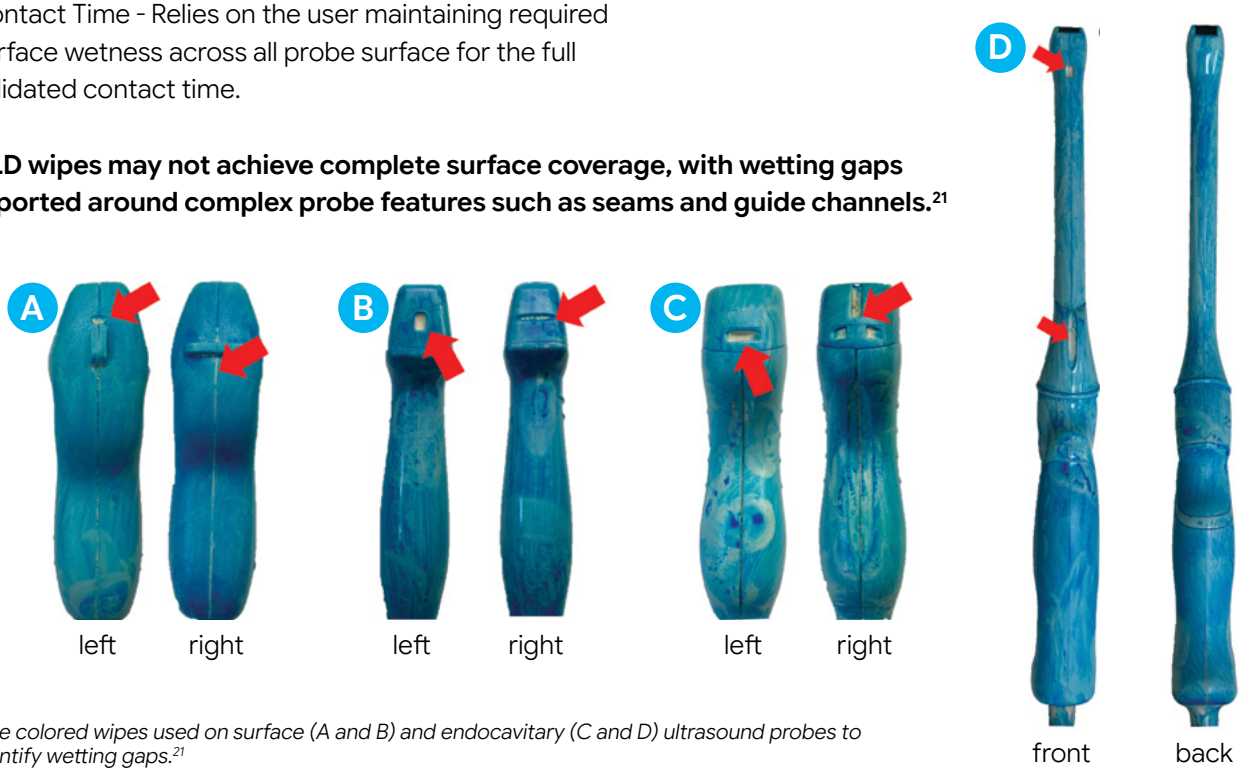
Foam-activated HLD wipes may present limitations across 3 of the 4 Cs:[7,20,21,27,28]

Concentration – Disinfectant concentration may vary due to user-dependent dosing and wipe dehydration.

Contact Time - Relies on the user maintaining required surface wetness across all probe surface for the full validated contact time.

Coverage - Complex surface topography may limit uniform wetting and surface coverage.

HLD wipes may not achieve complete surface coverage, with wetting gaps reported around complex probe features such as seams and guide channels.[21]



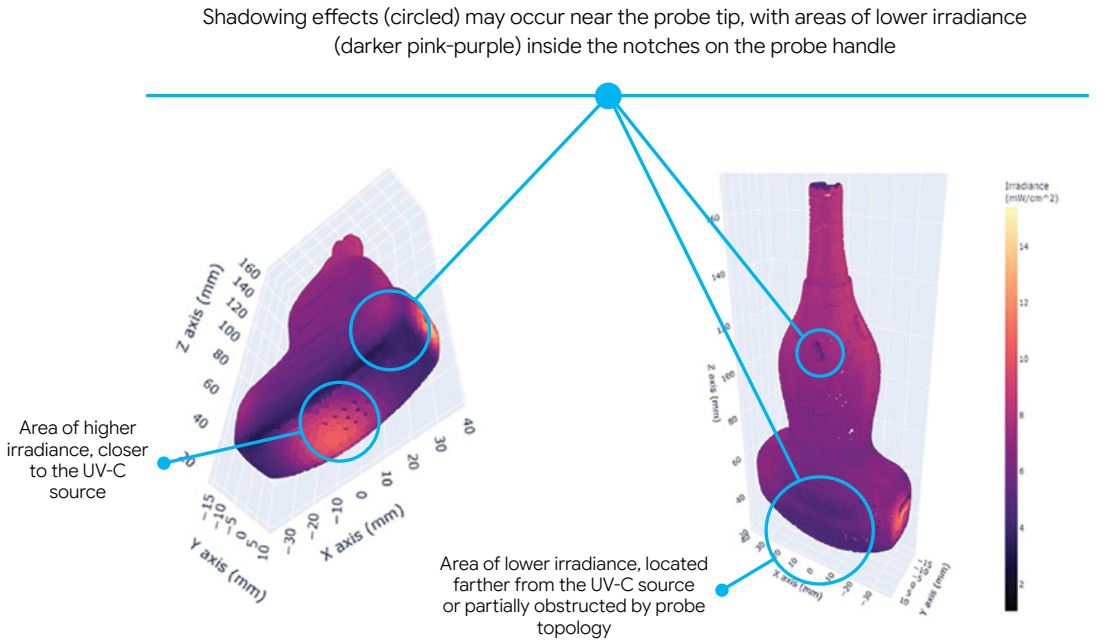
Blue colored wipes used on surface (A and B) and endocavitary (C and D) ultrasound probes to identify wetting gaps.[21]

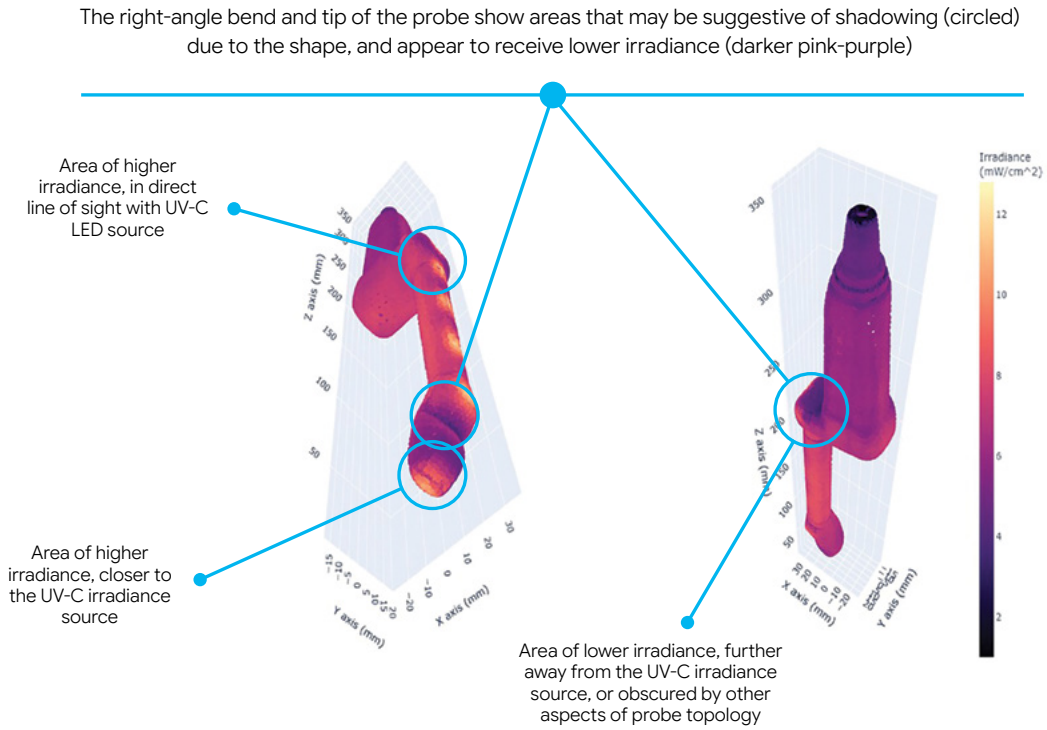
Increasing surface complexity and deviations from direct line-of-sight may reduce UV-C light dose delivery, limiting 2 of the 4 Cs[7-9,22-26]

Concentration or dose - UV-C technology is associated with large variation in irradiance distribution (dose) due to shadowing effects despite chamber reflection.

Coverage - shadowing, probe orientation, and surface complexity can limit irradiance reaching all surface areas of the probe.

Structural features of ultrasound probes can influence irradiance distribution, leading to areas of uneven irradiance (dose).[22]





3D scatter plots of the simulated irradiance distribution over the surface of a surface probe and an endocavity probe[22]

Confidence in trophon® technology through the 4 Cs

Chemistry	trophon uses hydrogen peroxide, a well-established disinfectant chemistry with decades of healthcare use in HLD and sterilisation.[10,12,15-18] Hydrogen peroxide has broad-spectrum antimicrobial activity supported by clinical studies.[10,11]
Concentration	trophon uses a sealed cartridge system and automated dosing process to deliver a validated hydrogen peroxide concentration during every cycle.[9] This eliminates manual mixing, dilution and concentration verification, helping to ensure consistent disinfectant delivery and reproducible disinfection performance.[9] An independent chemical indicator verifies delivery of the minimum effective dose.[9]
Contact Time	trophon automated cycle control maintains validated exposure conditions throughout the disinfection process reducing variability and supporting consistent disinfection outcomes.[9] The automation removes the need for manual timing and process monitoring.[9]
Coverage	trophon utilises sonically activated hydrogen peroxide mist to uniformly envelop the probe surface, including complex topographical features.[6,9] The automated mist delivery process is designed to distribute disinfectant across all exposed probe surfaces, supporting comprehensive surface coverage throughout the validated disinfection cycle.[9]

trophon technology, combines automation with sonically activated hydrogen peroxide mist to deliver on these four critical elements.[9-14]

Why healthcare facilities choose trophon technology[9]

Clinical efficacy[9,11,13,19]	Operational efficiency & safety[9]	Audit readiness[9]
Trusted hydrogen peroxide chemistry	4 minutes disinfection cycle that seamlessly integrates into every clinical workflow	DICOM connectivity
Automated delivery of validated concentration	Closed and controlled point of care solution protecting staff and patients	Connectivity to support workflow and quality assurance
Controlled contact time through automated cycle execution	trophon devices are ready to disinfect right when you need them	Electronic traceability and documentation
Full-surface coverage through sonically activated mist	Reduced dependence on manual technique	Operator, medical instrument and cycle tracking
Chemical indicator for MEC verification	Established compatibility with over 1,400 probes	Stores data securely
	Following disinfection, hydrogen peroxide rapidly breaks down into water and oxygen.	

MEC, Minimum Effective Concentration

Confidence for Staff. Confidence for Patients.
A closed, automated hydrogen peroxide system designed to support safe, consistent and reproducible HLD[9]

Scan the QR code to access information about trophon technology and HLD educational resources.

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