Clinical Literature Review

Title	Residual moisture and waterborne pathogens inside flexible endoscopes: Evidence from a multisite study of endoscope drying effectiveness
Authors	Ofstead, C.L., Heymann, O.L., Quick, M.R., Eiland, J.E., Wetzler H.P.
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Article Abstract	**Background** Endoscopy-associated infection transmission is frequently linked to inadequate reprocessing. Residual organic material and moisture may foster biofilm development inside endoscopes. This study evaluated the effectiveness of endoscope drying and storage methods and assessed associations between retained moisture and contamination. **Methods** Endoscope reprocessing, drying, and storage practices were assessed at 3 hospitals. Researchers performed visual examinations and tests to detect fluid and contamination on patient-ready endoscopes. **Results** Fluid was detected in 22 of 45 (49%) endoscopes. Prevalence of moisture varied significantly by site (5%; 83%; 85%; P<.001). High adenosine triphosphate levels were found in 22% of endoscopes, and microbial growth was detected in 71% of endoscopes. Stenotrophomonas maltophilia, Citrobacter freundii, and Lecanicillium lecanii/Verticillium dahliae were found. Retained fluid was associated with significantly higher adenosine triphosphate levels (P<.01). Reprocessing and drying practices conformed with guidelines at 1 site and were substandard at 2 sites. Damaged endoscopes were in use at all sites. **Conclusions** Inadequate reprocessing and insufficient drying contributed to retained fluid and contamination found during this multisite study. More effective methods of endoscope reprocessing, drying, and maintenance are needed to prevent the retention of fluid, organic material, and bioburden that could cause patient illness or injury.
Methods	• 45 patient ready endoscopes (13 colonoscopes, 12 gastroscopes, 5 duodenoscopes, 3 cystoscopes, 3 ureteroscopes, 3 endoscopic ultrasound scopes, 3 bronchoscopes, 2 intubation scopes, and 1 endobronchial ultrasound bronchoscope) from 3 Joint Commission accredited multispecialty hospitals were examined • Fully-reprocessed endoscopes that were representative of the site inventory and had been stored for >24 hours were included in the study • Channel effluent and swabs underwent ATP testing and culturing to detect microbial growth • Exterior surfaces and internal channels were visually examined with a camera and borescope and tested for residual moisture with a chemical indicator of endoscopes stored for 24 to 48 hours • Researchers observed endoscope reprocessing, drying, and storage practices • ATP tests were conducted on door handles, interior walls and floors of cabinets

Results	**Moisture Tests and Visual Examinations**
	• Water droplets were observed inside 21 of 45 internal channels (47%) with significant differences by site (A: 10 of 12 [83%]; B: 0 of 20 [0%]; C: 11 of 13 [85%]; P<.001)
	• Test strips detected water in 22 of 45 (49%) endoscopes, with significant differences by site (A: 10 of 12 [83%]; B: 1 of 20 [5%]; C: 11 of 13 [85%]; P<.001)
	• Oily fluid was observed on several endoscopes, and the fluid subsequently tested negative for water
	
	ATP Tests
	• Ten of 45 (22%) endoscopes had ATP levels >200 RLU (A: 3 of 12 [25%]; B: 1 of 20 [5%]; C: 6 of 13 [46%]; P=.012)
	• ATP levels for 31 of 45 (69%) endoscopes were ≥40 RLU (A: 7 of 12 [58%]; B: 12 of 20 [60%]; C: 12 of 13 [92%]; P = .087)
	  • Differences between Sites B and C were significant for the maximum ATP values per endoscope (P = .003) and surface ATP results (P = .002)
	  • Retained moisture was associated with higher maximum ATP levels (P<.01)
	
	Microbial Cultures
	• Microbial growth was detected in 32 of 45 (71%) endoscopes (A: 11 of 12 [92%]; B: 10 of 20 [50%]; C: 11 of 13 [85%]; P=.30)
	  • At Site B, microbial growth was found in 10 of 16 (62%) high-level disinfected endoscopes and in 0 of 4 (0%) sterilized endoscopes
	  • Colony counts were ≥10CFU for 4 of 12 (33%) endoscopes at Site A and for 6 of 13 (46%) endoscopes at Site C
	  • Colonies were too numerous to count for 2 of 12 (17%) endoscopes at Site A and for 5 of 13 (38%) endoscopes at Site C
	
	Visual Examinations
	• Substantial defects were observed in all 45 endoscopes
	  • Irregularities included discoloration, white or black residue, scratches, gouges, non-intact channel lining, debris inside endoscopes, damaged distal ends, insertion tube buckling, and dented channels
	
	Reprocessing, Drying, and Storage Methods
	• All sites were using AERs with paracetic acid HLD (Steris Reliance, Steris 1E, Medivators Advantage)
	• Multiple reprocessing deficiencies were observed at Site A
	  • Dirty-to-clean workflow and PPE use were substandard, leak testing and manual cleaning were inadequate, no hand hygiene was performed between reprocessing activities, no cleaning-verification tests or visual inspections of endoscopes were done
	  • AER automated cleaning cycles were disabled to save time
	  • No alcohol flush or air purge were performed
	  • Wet gastrointestinal scopes were hung vertically in a storage cabinet with dirty filters, and no active ventilation

	• Wet cystoscopes, ureteroscopes, and intubation endoscopes were stored in a small, visibly dirty, unventilated cabinet with reused Styrofoam blocks to protect distal tips, with 1 ureteroscope stored horizontally at the bottom of the cabinet due to insufficient storage space
	• Reprocessing practices at Site B conformed with current guidelines
	  • Dirty-to-clean workflow, proper PPE, manual cleaning was meticulous, cleaning effectiveness was verified using a biochemical test prior to HLD
	  • Automated cleaning cycle in AER used before HLD
	  • After HLD, alcohol flush and air purge were performed in AER
	  • External surfaces of scopes were wiped with clean, lint-free towels, internal channels were purged for 10 minutes using pressure regulated, medical-grade forced air
	  • Scopes were stored vertically in cabinets with continuous circulation of HEPA-filtered air around external surfaces
	• Multiple reprocessing deficiencies were observed at Site C
	  • Dirty-to-clean workflow and PPE use were substandard, leak testing and manual cleaning were inadequate, no hand hygiene was performed between reprocessing activities, no cleaning-verification tests or visual inspections of endoscopes were done
	  • AER automated cleaning cycles were disabled to save time
	  • After HLD, alcohol flush and air purge were performed in AER
	  • External surfaces of scopes were wiped with reused towels, internal channels were purged for 15-20 seconds using a non-pressure regulated air pistol
	  • Scopes were stored vertically in ventilated cabinets, but cabinet fans were disabled
	• ATP tests were completed for at least 1 cabinet at each site. ATP levels in storage cabinets at all 3 sites indicated residual contamination (maximum levels on cabinet door handles, interior walls, and floors at A: 898, 247, 44; B: 53, 900, 85; C: 161, 286, 4219 RLU).

Conclusions	• Inadequate reprocessing and insufficient drying contributed to retained fluid and contamination. • More effective methods of reprocessing/drying are needed to prevent retention of fluid, organic material, and bioburden.

Messaging	• Accredited hospitals that are following guidelines are still susceptible to breaches in flexible endoscope reprocessing, even those following “very good practices” are at risk.
	• Breaches in reprocessing protocols were observed at 2/3 TJC accredited sites.
	  • At these sites 85% and 92% of scopes tested positive for microbial growth.
	  • At the site where all protocols were being followed, 50% of scopes tested positive for microbial growth.
	• Ten minutes of drying using pressure regulated medical grade air in a HEPA filtered storage area can significantly reduce moisture **BUT NOT ELIMINATE MICROBIAL GROWTH.**