Hung Out to Dry: The Importance of Endoscope Channel Drying Prior to Storage

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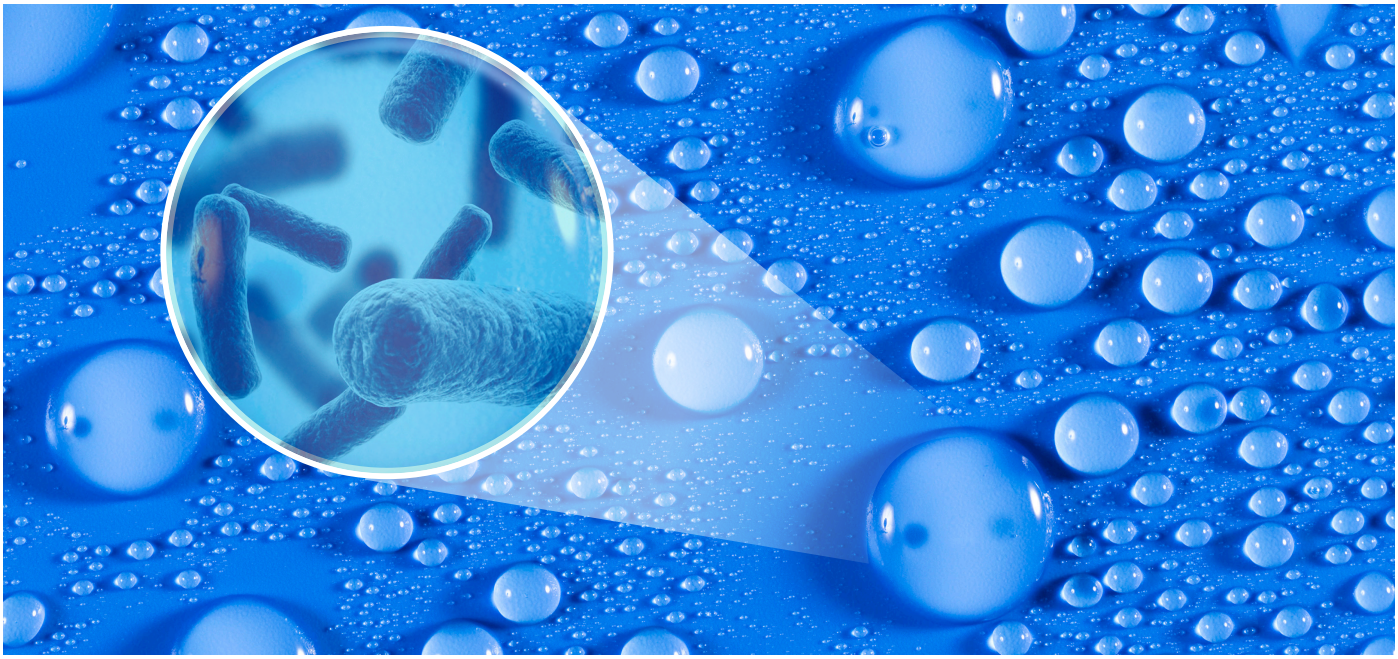
Introduction

Endoscope reprocessing is a topic that has been discussed at length in recent times. With ever-increasing concern over nosocomial infections, correct disinfection practices, and antibiotic resistant microorganisms, the healthcare industry is more aware of the importance of correct reusable medical device reprocessing than ever before. While most discussions on flexible endoscope reprocessing tend to center around the critical nature of effective manual cleaning and disinfection, the significance of drying and storage is a topic that has more recently come to the forefront of the industry.

Once error-free endoscope cleaning and disinfection has been performed, how can the addition of a drying process help maintain a patient-safe device until the next procedure?

Residual moisture within endoscope lumens during storage can help create a suitable environment for the growth of any bacteria that may remain after disinfection, waterborne pathogens present in rinse water, and even environmental contaminants.



The creation and maintenance of dry storage conditions help to prevent bacterial growth and preserve the cleanliness of the reprocessed endoscope.[1,2,3,4]

These dry conditions can be achieved in one of two ways: manually drying the endoscope lumens with filtered pressurized air for an extended period of time after high-level disinfection and before storage in a conventional endoscope storage cabinet, or placing the reprocessed endoscopes directly into a drying cabinet.[5,6]

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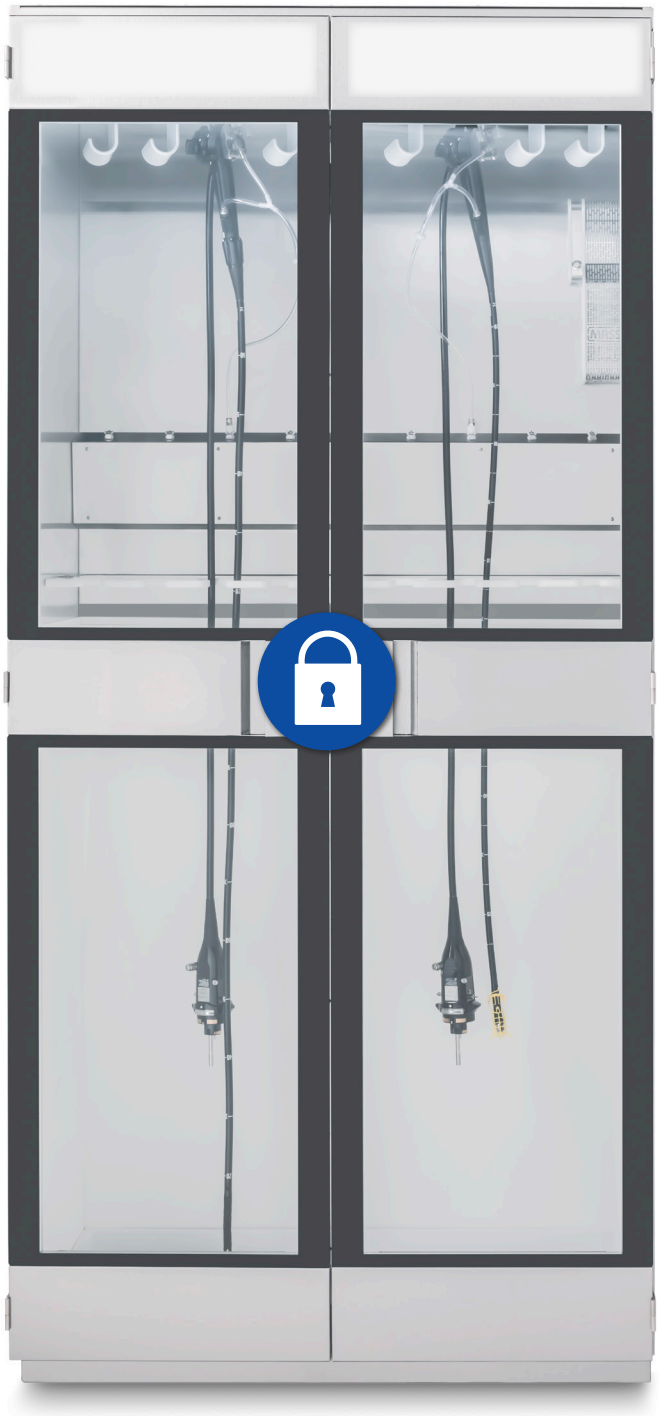
Types of Storage

Conventional storage cabinets provide a safe storage space by helping to prevent physical damage to the endoscope. Endoscopes are generally hung on specially designed hooks which support the control body and allow the insertion tube and light guide connector to hang vertically and freely.

Newer conventional storage cabinets offer HEPA-filtered ventilation within the cabinet. This ventilation maintains clean air in the environment surrounding the endoscope, but does little for residual moisture in the lumen of the device. Endoscope lumens should be completely dry before storing as this circulated air is not injected directly into the channels. during storage.[5,6]



Drying cabinets, or active drying cabinets, provide all of the benefits of a conventional storage cabinet with the added benefit of being able to continuously blow pressurized, filtered air through the endoscope's channels.

- This not only dries the channels if they were not completely dry before storage, but maintains this dry environment throughout the entire duration of storage.
- This deters the growth of microorganisms, helps prevent environmental contaminants from coming into contact with the endoscope, and mitigates the potential for human error that accompanies manually drying endoscope lumens before storage.[5,6]

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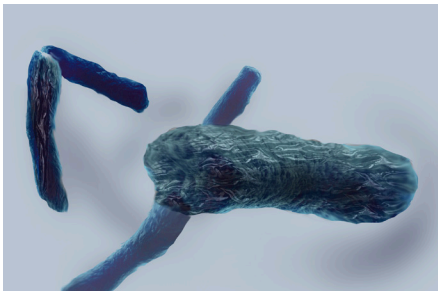
Benefits of Dry Storage

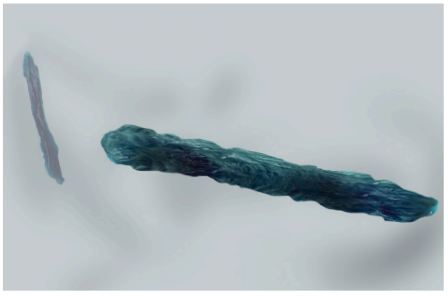
When considering the importance of dry storage for flexible endoscopes, it is important to understand why dry environments are inhospitable to the majority of bacteria. The role of water is crucial to the physiology and cellular function of most organisms.[7] Cells require water molecules for essential functions including protein regulation, nutrient uptake, and DNA replication.[7,8] As bacterial cells are approximately 70% water, it is difficult or impossible for them to cope with the effects of water removal via air drying.[7] When the water content of a cell falls outside of the normal range of functional activity, some essential functions become impaired and the viability of the cell is damaged or impaired.[8] If the water content is not restored, or in certain cases even if it is restored, the bacteria are weakened and are much less likely to regain normal cellular function.

If a microorganism cannot multiply, then it cannot lead to infection in the majority of situations.[9]

Illustrated: Bacteria thriving in moist environment.



Illustrated: Cell impairment and decreased number of living bacteria.



Illustrated: Bacteria in dry environment are damaged and no longer viable.

Endoscope instruction manuals and guidelines alike stress the importance of drying endoscope channels before storage. But what happens when endoscopes are stored and residual moisture remains? Just as dry conditions damage bacteria and impede their growth, moist conditions contribute to a hospitable environment and assist in the multiplication of bacteria.[1,10]

High level disinfection inactivates most microorganisms except for some bacterial spores.[6,11] Though considered safe and effective for the reprocessing of flexible endoscopes used in semi-critical procedures, high-level disinfection is not a sterile process and therefore even when it is performed properly there may be residual microorganisms remaining. If any moisture remains within the endoscope channels during storage, these few possible remaining bacterial cells may be able to proliferate to more than a million colony-forming units in a matter of hours.[2,5,12,13,14] Evidence shows that in the absence of adequate drying, residual bacteria not only multiplied within endoscope channels but biofilms were more likely to form and/or regrow in the extended presence of moisture.[1,4,10,15]

The presence of residual moisture can also aide in the growth of pathogens present in rinse water. The physical properties of tap water may change unexpectedly and introduce pathogenic organisms that have the potential to cause infections. These changes can be caused by weather events, water treatment deficiencies, or the infrastructure and state of disrepair of the water system itself.[16-19] All endoscope reprocessing utilizes water during multiple steps including the rinsing removal of the high-level disinfectant chemical as the last process before drying and storage.[20]

Endoscopes that are stored wet have been linked with the transmission of waterborne organisms and as the cause of associated nosocomial infections.[2,3] The unintended use of contaminated water for rinsing of high-level disinfected endoscopes can recontaminate an otherwise disinfected and patient-safe endoscope even if the reprocessing steps were perfectly performed.[3,21]

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What Does the Literature Say?

So what are the benefits of endoscope channel drying prior to storage? Studies have shown that ten minutes of additional channel drying after the completion of an automated endoscope reprocessor cycle resulted in dry channels and prevented the growth of microrganisms during storage.[1,2,15,21] These results suggest that drying is critically important, and further imply that the reason for contamination after high-level disinfection may not solely lie with the reprocessing process or associated equipment.[1,2,4,15,21]

Several studies have specifically looked at the effects of using drying cabinets with flexible endoscopes. All have found that when endoscopes are dried properly and stored in drying cabinets, the level of cleanliness achieved after high-level disinfection is maintained. Furthermore, the detrimental nature of dry air to bacteria may even decrease the level of microbial contamination, if any remain after disinfection.[4,7,22]

In cases where waterborne pathogens may be present, an alcohol-flush and subsequent active air drying play a key role in preventing their proliferation during endoscope storage.[3,4,11,12,22,23] Taking all of the available evidence into account, the use of drying cabinets can improve the microbiological quality of flexible endoscopes after high-level disinfection and storage.

What Do the Guidelines Recommend?

Currently, professional guidelines on endoscope reprocessing are varying in their recommendations regarding the active drying of flexible endoscopes. While all guidelines state the importance of drying before storage, some do not have definitive statements notifying the user of a requirement for flexible endoscope channel drying or dry storage of endoscopes. Active drying cabinets are more popular in Europe than they are in the United States, and this is somewhat reflected in the European guidelines.

Current Guideline Recommendations	
Major guidelines within the United States, as well as a sampling of several international publications	
Association for the Advancement of Medical Instrumentation[11]	"Before storage, the channel of the high-level disinfected endoscope should be dry to help prevent bacterial growth and the formation of biofilm." "All channels should be purged with filtered medical grade air at the correct psi." "Drying can be achieved by flowing air through all endoscopes channels for a specified period of time." "The endoscopic personnel need to understand the role moisture plays in contributing to microbial growth after the high-level disinfection process."
Association of periOperative Registered Nurses [6]	"Flexible endoscopes should be stored in a drying cabinet." "The collective evidence shows that optimal storage of flexible endoscopes facilitates drying, decreases the potential for contamination, and provides protection from environmental contaminants."
American Society for Gastrointestinal Endoscopy [12]	"After HLD, rinse the endoscope and flush the channels with sterile or filtered water to remove the disinfectant solution. Discard the rinse water after each use/cycle. Flush the channels with 70% to 90% ethyl or isopropyl alcohol and dry using filtered forced air. The final drying steps greatly reduce the risk of remaining pathogens and the possibility of recontamination of the endoscope by waterborne microorganisms."

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Centers for Disease Control and Prevention[13,24]	"...a tapwater or filtered water (0.2µ filter) rinse should be followed by an alcohol rinse and forced air drying. Forced-air drying markedly reduces bacterial contamination of stored endoscopes, most likely by removing the wet environment favorable for bacterial growth. After rinsing, items should be dried and stored (e.g., packaged) in a manner that protects them from recontamination."[13] "...rinse the insertion tube and inner channels with alcohol, and dry with forced air after disinfection and before storage."[13] "Drying the endoscope is essential to greatly reduce the chance of recontamination of the endoscope by microorganisms that can be present in the rinse water."[13] "After reprocessing is complete, store endoscopes and accessories in a manner that prevents recontamination, protects the equipment from damage, and promotes drying."[24]
Society of Gastroenterology Nurses and Associates[5]	"In order to ensure that endoscopes are thoroughly dried, they must be flushed with 70% to 90% isopropyl alcohol and dried with pressurized, filtered, air (either by AER or manually)." "Drying is a critical element in reprocessing. Moisture allows microorganisms to survive and multiply; therefore, all channels and the surface of the endoscope must be thoroughly dried before storage." "Drying the endoscope after every reprocessing cycle, both between patient procedures and before storage, is a requisite practice crucial to the prevention of bacterial transmission and nosocomial infection."
European Society of Gastrointestinal Endoscopy[23]	"Endoscope channels should be dried with compressed filtered air." "Before storage, thorough drying of endoscopes is necessary to prevent the growth of waterborne microorganisms." "...staff should check the quality of the final drying and if necessary, dry the endoscope manually with compressed filtered air before storage."
Gastroenterological Society of Australia[25,26]	"All endoscopic instruments, except those in sterile packaging, should be stored in TGA-approved forced air drying cabinets."[25] "Force air dry all channels until no moisture emerges from the distal tip."[26] "Cupboards used to store endoscopes must be either designed to hold endoscopes horizontally on a flat surface with continuous air flow through each channel, or be tall enough to allow endoscopes to hang vertically without touching the floor and be well ventilated or have continuous air flow through each channel"[26] "Cupboards with continuous air flow should provide filtered air, flow monitoring and audible alarms in the event of failure. If air flow fails, the connections to the cupboard air flow lines will impair fluid drainage and evaporation of residual moisture within endoscope." [26]
British Thoracic Society[27]	"Drying cabinets/storage chambers are recommended for storing clean bronchoscopes."
World Gastroenterology Organisation[28]	"Always dry the endoscope properly before storage to prevent microorganism growth in the endoscope channels." "Recommendations for effective disinfection with a liquid chemical germicide include...Drying each endoscope properly with forced air." "Drying of endoscopes especially prior to prolonged storage decreases the rate of bacterial colonization. Forced air-drying adds to the effectiveness of the disinfection process."

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Conclusion

Drying of endoscope channels before storage is a critical step in endoscope reprocessing, and the current body of evidence supports this claim. Effective drying maintains the level of cleanliness achieved after endoscope reprocessing during storage and helps prevent disease transmission by residual microorganisms and waterborne pathogens.[2,5,6] In addition to proper manual cleaning and high-level disinfection, drying is another principal step in endoscope reprocessing. The understanding of its importance is critical to providing each patient with a safe endoscope for each procedure.

Studies show that an extended drying step after automated endoscope reprocessing is adequate for preventing the proliferation of residual contaminants during storage. However, drying cabinets take away the hands-on time required for manual air drying and decrease the risk of human error that may occur during the process. Cabinets that continuously purge filtered medical-grade air through endoscope channels and around the outside of the endoscope create and maintain the dry conditions that are difficult for bacteria to live and thrive in - all without requiring much intervention from endoscope technicians.[4,7,8]

Drying cabinets provide a dry and well-ventilated environment for flexible endoscope storage, which helps protect patients from the risks of nosocomial infection.

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