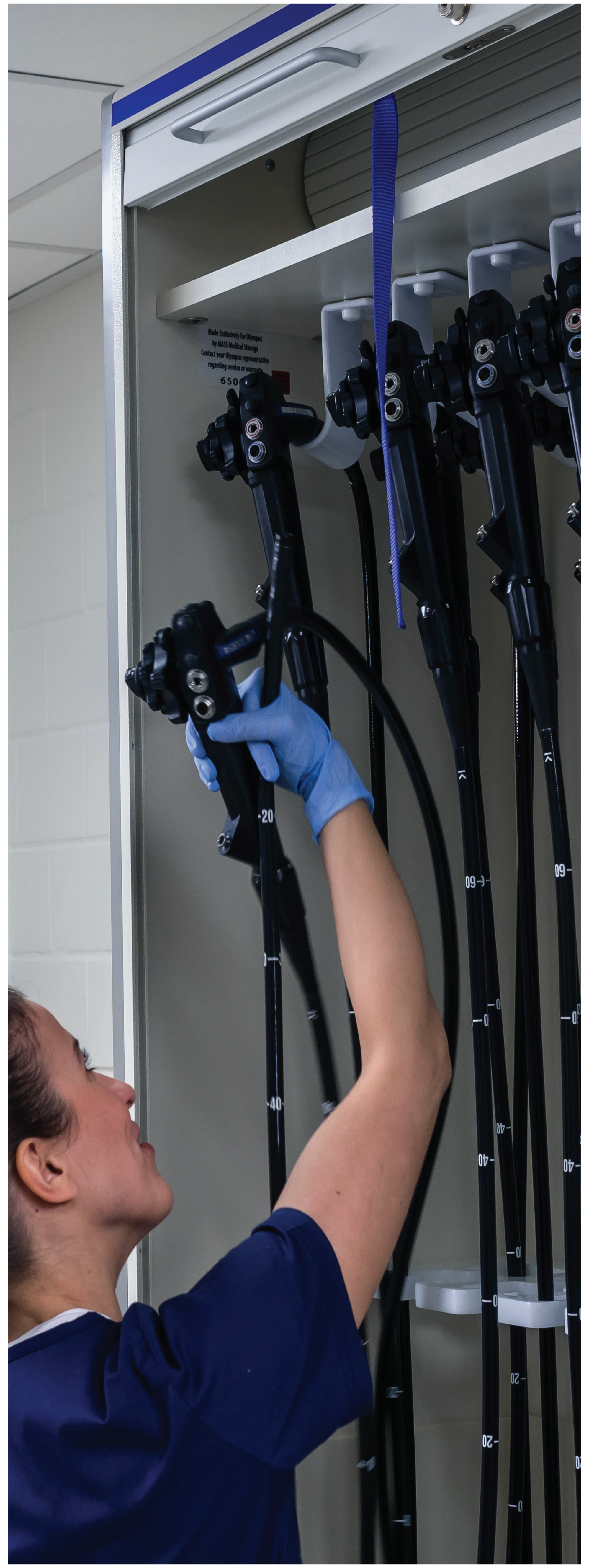


Hung Out to Dry:
Effects of Pre-Storage Drying on Bacterial Growth in Flexible Endoscopes

Melinda Benedict, MS, CIC, CFER / Olympus Corporation of the Americas

Introduction

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.

Dry storage conditions may prevent bacterial growth and preserve the cleanliness of the reprocessed endoscope. This can be acheived in one of two ways:

- Manually drying the endoscope lumens with pressurized instrument or medical grade air for an extended period of time after high-level disinfection and before storage in a conventional endoscope storage cabinet.
- Placing the reprocessed endoscopes directly into a drying cabinet.[1-6]

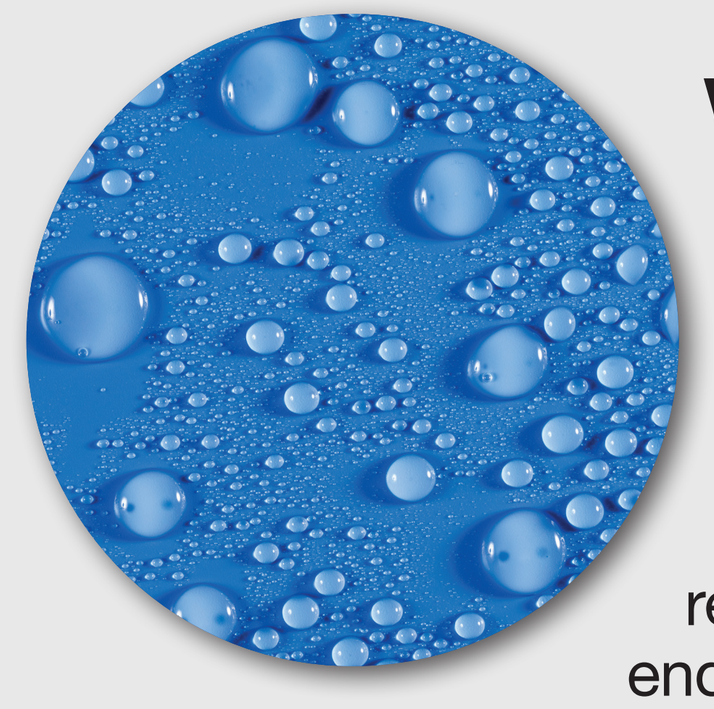
Effects of Dry Air on Bacterial Growth

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.[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]



What happens when residual moisture remains?

Moist conditions contribute to a hospitable environment for bacterial growth.[1,10] High-level disinfection is not a sterile process and residual microorganisms, such as bacterial spores, may remain on the endoscope after reprocessing. If moisture remains within the endoscope channels during storage, any 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]

Additionally, the unintended use of contaminated water for rinsing of high-level disinfected endoscopes can recontaminate an otherwise disinfected and patient-safe endoscope.[3,16] Endoscopes that are stored wet have been linked with the transmission of waterborne organisms due to contaminated rinse water.[2,3]

What does the literature say?

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.[1,2,15,16]

Several studies have specifically looked at the effects of using drying cabinets with flexible endoscopes. The results have indicated when endoscopes are 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 remains after reprocessing.[4,7,17]

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.[3,4,11,12,17,18]

What do the guidelines recommend?

Currently, professional guidelines vary in their recommendations regarding the drying of flexible endoscopes. At present, active drying cabinets are more popular in Europe than in the United States and this is reflected within some European society guidelines. Below is a sampling of excerpts from guidelines related to endoscope drying taken from domestic and international professional guidelines:

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."
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]	"The final drying steps greatly reduce the risk of remaining pathogens and the possibility of recontamination of the endoscope by waterborne microorganisms."
Centers for Disease Control and Prevention[13,19]	"Forced-air drying markedly reduces bacterial contamination of stored endoscopes, most likely by removing the wet environment favorable for bacterial growth."[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."[19]
Society of Gastroenterology Nurses and Associates[5]	"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[18]	"Endoscope channels should be dried with compressed filtered air." "Before storage, thorough drying of endoscopes is necessary to prevent the growth of waterborne microorganisms."
Gastroenterological Society of Australia[20,21]	"All endoscopic instruments, except those in sterile packaging, should be stored in TGA-approved forced air drying cabinets."[20] "Force air dry all channels until no moisture emerges from the distal tip."[21]
World Gastroenterology Organisation[23]	"Always dry the endoscope properly before storage to prevent microorganism growth in the endoscope channels." "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."

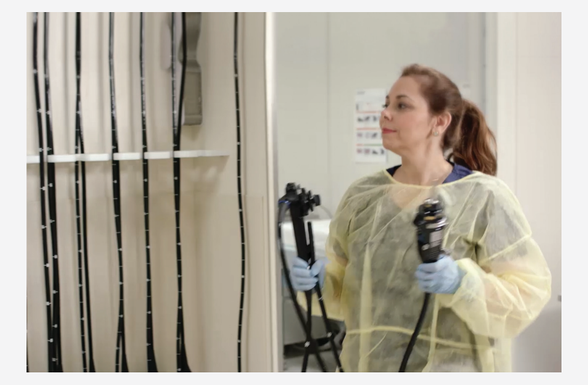
Conclusion

In addition to proper manual cleaning and high-level disinfection, drying is another principal step in endoscope reprocessing.

Effective drying helps maintain the level of cleanliness achieved after endoscope reprocessing during storage and may prevent disease transmission of residual microorganisms and waterborne pathogens.[2,5,6]

Drying prior to storage can be achieved in several ways. Perhaps the most effective method is through the use of active drying cabinets.

- Dying cabinets continuously purge filtered air through endoscope channels and around the outside of the endoscope to 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.



Storage Cabinets:
Which Type is Right for My Facility?

Storage Cabinet Type	Description	Pros	Cons
Storage cabinets or other storage solutions not specifically designed for endoscope storage	Endoscope storage methods that are not indicated for endoscope storage. Examples include retrofitted kitchen/utility-type cabinets, converted closets, or wall-mounted hangers in open areas.	• Cost-effective • Can be customized to fit available space	• May be constructed out of materials that do not provide a safe storage environment (i.e. pressed board, drywall) • May lack adequate ventilation • No air filtration • Often no defined disinfection or cleaning instructions • Materials may be porous which could allow retention of moisture or debris"
Conventional endoscope-specific storage cabinets	Cabinets that are designed and manufactured for the sole purpose of storing endoscopes. Many models have a HEPA filtration component to filter air within the cabinet.	• Designed to safely store endoscopes • Available HEPA filtration may decrease risk of environmental contamination • Can be disinfected • More cost-effective than active drying cabinets	• Only ventilates around outside of endoscope and not within endoscope channels • Endoscopes should be dried using manual drying methods before placing into storage
Active drying endoscope storage cabinets	Cabinets that actively push filtered air through endoscope channels during storage to maintain dry conditions. Circulates HEPA-filtered air around the outside of the endoscopes.	• Controls air quality and humidity • Replaces the need to manually dry the endoscope channels after HLD • Maintains dry conditions, which may decrease risk of environmental contamination • May reduce levels of bacteria that may remain after reprocessing • Can be disinfected	• Most expensive storage solution • Need direct line into hospital ar system unless separate air compressor is purchased (if available) • Must ensure proper psi of air to avoid endoscope damage

ADDRESS CORRESPONDENCE TO:
Melinda Benedict, MS, CIC, CFER
Olympus Corporation of the Americas
3500 Corporate Parkway
Center Valley, PA 18034
melinda.benedict@olympus.com

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