COMMENTARY

Lessons Learned From Outbreaks and Pseudo-Outbreaks Associated with Bronchoscopy

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(See the article by Cosgrove et al, on pages 224–229.)

The bronchoscope has been an invaluable tool for the diagnosis and therapy of pulmonary diseases for more than a century.[1] An estimated 497,000 bronchoscopies were performed in the United States in 1996, 305,000 in inpatients and 192,000 in ambulatory patients.[2] More recent data from 2006 reported a slight decrease in the number of bronchoscopies: 282,000 in inpatients[3] and 173,000 in ambulatory patients.[4] Bronchoscopy is widely used for both diagnosis and therapy of pulmonary diseases. Current and new diagnostic methods include autofluorescence bronchoscopy, endobronchial ultrasonography, navigational bronchoscopy, and fibered confocal fluorescence microscopy.[5,6] Advances in interventional bronchoscopy include argon plasma coagulation, electrocautery or laser ablation, airway stents, cryotherapy, brachytherapy, and photodynamic therapy.[7] Flexible endoscopes are also widely used in other medical disciplines, especially to diagnose and treat disorders of the gastrointestinal tract.

Endoscopes represent the medical devices most commonly linked to healthcare-associated outbreaks and pseudo-outbreaks. Flexible endoscopes present a challenge for low-temperature sterilization or high-level disinfection, because they have long, narrow lumens, cross-connections, mated surfaces, sharp angles, springs and valves, occluded dead ends, absorbent material, and rough or pitted surfaces. Failure to eradicate contamination that occurs during use may lead to person-to-person transmission of pathogens (eg, *Mycobacterium tuberculosis*), while failure to prevent contamination during disinfection or storage may lead to outbreaks or pseudo-outbreaks from environmental pathogens (eg, nontuberculous mycobacteria, *Legionella* sp.). In an excellent review of infections transmitted by flexible endoscopes, Spach and colleagues summarized 9 outbreaks or pseudo-outbreaks associated with bronchoscopy from 1975 to 1989.[8] In 2001, Weber and Rutala[9] reviewed the literature and summarized an additional 3 outbreaks and 22 pseudo-outbreaks associated with bronchoscopy between 1990 and 1999. Despite the publication of multiple authoritative guidelines by professional societies, outbreaks and pseudo-outbreaks continue to occur, with 24 reports published since 2000 (Table 1).[10-34] In this issue, Cosgrove and colleagues[10] report yet another pseudo-outbreak associated with bronchoscopy.

Outbreaks and pseudo-outbreaks associated with bronchoscopy continue to occur because of poor adherence to current disinfection guidelines, especially the failure of healthcare facilities to have policies and procedures consistent with the current guidelines. Training and periodic assessment of competency of persons performing cleaning and disinfection is an important component of preventing breaches in policy. It is crucial for infection control preventionists to continue to report outbreaks and pseudo-outbreaks, since these reports aid in improving the manufacture of endoscopes, methods of disinfection, and policies/procedures to prevent cross-transmission. The sources of contamination leading to outbreaks and pseudo-outbreaks of endoscopes have been reviewed.[9,35] Contamination most commonly results from failure to adhere to the key steps in disinfection (see below): appropriate cleaning, disinfection, rinsing, drying, and/or storage (Table 2). Outbreaks and pseudo-outbreaks have also resulted from contamination of fluids that may be instilled during bronchoscopy, including topical anesthesia (eg, cocaine), the green dye added to the anesthetic, and the atomizer used to instill analgesia.[35] Pseudo-outbreaks have also resulted from contamination of respiratory tract specimens in the microbiology laboratory.[36] However, most recent outbreaks and pseudo-outbreaks have resulted from contaminated automatic endoscope reprocessors or the use of damaged or malfunctioning bronchoscopes. Outbreaks or pseudo-outbreaks have resulted from contaminated equipment, including rinsing tanks, tubing, antibacterial filters on water lines, cleaning brushes, and biofilms in the reprocessor. Outbreaks have led to the recall of poorly designed or poorly functioning bron-

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TABLE 1. Outbreaks and Pseudo-Outbreaks Associated with Bronchoscopy, 2000–2012

Reference	Publication year	Microorganism	Outbreak or pseudo-outbreak?	Isolates	Infections	Deaths	Source of contamination
Cosgrove et al[10]	2012	*Pseudomonas* sp., *Stenotrophomonas*	Pseudo-outbreak	16	0	0	Irregularities in repair by third-party vendor, nonstandard part replacements
Rosengarten et al[11]	2010	*Burkholderia cepacia*	Pseudo-outbreak	3	0	0	Missing antibacterial filter on washer disinfector
CDC[12]	2009	*Legionella pneumophilia*	Pseudo-outbreak	4	0	0	Nonsterile ice used to cool saline filler syringes for bronchoalveolar lavage
Schuetz et al[13]	2009	*L. pneumophilia*	Pseudo-outbreak	13	0	0	Immersion of uncapped saline-filled syringes in contaminated ice
Chroneou et al[14]	2009	*Mycobacterium chelonae*	Pseudo-outbreak	9	0	0	Contamination of an AER
DiazGranados et al[15]	2009	*Pseudomonas aeruginosa*	Both	12	2	0	Damaged bronchoscope
Schaffer et al[16]	2008	*Fursarium solani*	Pseudo-outbreak	4	0	0	Bronchoscope
Shimono et al[17]	2008	*P. aeruginosa*	Outbreak	7	7	0	Flaw in AER, failure to properly clean and disinfect bronchoscopes
Ahn et al[18]	2007	*Stenotrophomonas maltophilia*	Pseudo-outbreak	7	0	0	Failure to properly clean and disinfect bronchoscopes
Bou et al[19]	2006	*P. aeruginosa*	Outbreak	10	10	0	Failure to properly clean and disinfect bronchoscopes
Corne et al[20]	2005	*P. aeruginosa*	Both	16	4	0	Damaged internal channel caused by defective biopsy forceps
Cêtre et al[21]	2005	Enteric GNR	Both	117	2	0	Bronchoscope: loose port of the biopsy channel
Larson et al[22]	2003	*Mycobacterium tuberculosis*	Pseudo-outbreak	3	1	0	Failure to properly clean bronchoscopes, use of an AER not approved for the type of bronchoscope
Singh et al[23]	2003	*Trichosporon mucoides*	Pseudo-outbreak	6	0	0	Defective bronchoscopes
Silva et al[24]	2003	*P. aeruginosa, Serratia marcescens*	Pseudo-outbreak	41	0	0	Failure to properly clean bronchoscopes
Srinivasan et al[25]	2003	*P. aeruginosa*	Outbreak	97	48	3?	Defective bronchoscopes: loosened biopsy port
Kirschke et al[26]	2003	*P. aeruginosa*	Both	20	1	0	Defective bronchoscopes: loosened biopsy port
Ramsey et al[27]	2002	*M. tuberculosis*	Pseudo-outbreak	10	4	0	Damaged bronchoscope; no leak testing; hole in bronchoscope sheath
Rossetti et al[28]	2002	*Mycobacterium gordonae*	Pseudo-outbreak	16	0	0	AER: failure to replace antibacterial filters, maintenance
Kressel and Kidd[29]	2001	*M. chelonae, Methylobacterium mesophilicum*	Pseudo-outbreak	20	0	0	AER contaminated with biofilm resistant to decontamination
Sorin et al[30]	2001	*P. aeruginosa*	Both	18	3	1	AER: inappropriate channel connectors
Kramer et al[31]	2001	*P. aeruginosa*					AER: disinfectant (0.04% glutaraldehyde) contaminated because of inadequate concentration (concentration mistakenly set too low)
Wilson et al[32]	2000	*Aureobasidium* sp.	Pseudo-outbreak	10	0	0	Reuse of single-use stopcocks
Gillespie et al[33]	2000	*M. chelonae*	Pseudo-outbreak	2	0	0	Contaminated water in AER
Schelenz and French[34]	2000	*P. aeruginosa*	Unknown	8	0	0	AER

NOTE. AER, automated endoscope reprocessor; GNR, gram-negative rods.

TABLE 2. Steps in the Disinfection Process and Mechanisms of Failure

Disinfection step	Reason for disinfection step	Mechanism for failure
Cleaning	Remove bioburden Remove substances that might interfere with disinfection: blood, salt, protein	Inadequate policies; Inadequate training or supervision; failure to clean immediately (ie, allowing body fluids to dry); failure to brush all channels; damaged internal channel(s); poorly mated internal components
Appropriate disinfectant	Inactivation of contaminating microbes	Ineffective disinfectant (eg, iodides); inadequate concentration; inadequate duration; inadequate temperature
Contact between disinfectant and contaminating microbes	Requirement for killing	AER: failure to use channel connectors; AER: wrong channel connectors; occluded lumen; torn or damaged lumen
Rinse	Remove potentially toxic chemicals (eg, glutaraldehyde, hydrogen peroxide)	Mucous membrane damage to subsequent patient (eg, colitis); contaminated rinse water
Prevention of recontamination	Prevent contamination with environmental microbes	Tap water rinse without subsequent alcohol rinse; failure to air-dry endoscope; contaminated AER; reassembly of valves before storage; placement of endoscope in contaminated container; storage in coiled position (rather than hanging straight)

NOTE. AER, automatic endoscope reprocessor.

choscopes.[23,25] While pseudo-outbreaks due to damaged bronchoscopes have been reported,[14] the article by Cosgrove and colleagues[10] adds to the literature by illustrating the importance of proper repair and maintenance of bronchoscopes and the possibility of damage by third-party vendors.

The proper method for high-level disinfection or sterilization of flexible endoscopes is well described in current guidelines.[37-40] Endoscope high-level disinfection or sterilization with a liquid chemical sterilant involves five steps after leak testing:

1. *Clean.* Mechanically clean internal and external surfaces, including brushing of internal channels and flushing of each internal channel with water and a detergent or enzymatic cleaners (leak testing is recommended for endoscopes before immersion).
2. *Disinfect.* Immerse endoscope in high-level disinfectant (or chemical sterilant), perfuse disinfectant into all accessible channels (eliminating air pockets and ensuring contact of the germicide with the internal channels), such as the suction/biopsy channel and the air/water channel, and expose for a time recommended for specific products.
3. *Rinse.* Rinse the endoscope and all channels with sterile water, filtered water (commonly used with automatic endoscope reprocessors), or tap water (ie, high-quality potable water that meets federal clean-water standards at the point of use).
4. *Dry.* Rinse the insertion tube and inner channels with alcohol and dry with forced air after disinfection and before storage.
5. *Store.* Store the endoscope in a way that prevents recontamination and promotes drying (eg, hanging vertically).

Drying the endoscope (steps 3 and 4) is essential for greatly reducing the chance of recontamination of the endoscope by microorganisms that may be present in the rinse water.

There continue to be several areas of controversy regarding endoscope reprocessing, including the need to perform the final rinse with sterile water or water filtered by an automatic endoscope reprocessor, the need to reprocess endoscopes immediately before use, and the use of routine culturing of endoscopes to demonstrate appropriate cleaning and disinfection. These issues are all discussed in the most recent guideline on sterilization and disinfection by the Centers for Disease Control and Prevention (CDC) and the Healthcare Infection Control Practices Advisory Committee (HICPAC), which has detailed recommendations regarding endoscopes.[37] Because tap water may contain low levels of microorganisms,

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some have suggested that only sterile water (which may be prohibitively expensive) or filtered water using an automated endoscope reprocessor be used. The suggestion to use only sterile water or filtered water is not consistent with published guidelines that allow tap water with an alcohol rinse and forced-air drying or with the scientific literature. In addition, there has been no evidence of disease transmission when tap water followed by an alcohol rinse and forced-air drying has been used. Because of concerns about recontamination, some have recommended that endoscopes be reprocessed immediately before use. However, on the basis of studies that have assessed the microbiological stability of endoscopes after high-level disinfection, it appears that reprocessing after storage for 1 or 2 weeks is unnecessary. Currently, the CDC/HICPAC guideline does not recommend routine culturing of reprocessed endoscopes or the final rinse water. This is because the routine culturing of neither reprocessed endoscopes nor the final rinse water has been validated by correlating viable counts on an endoscope to infection following an endoscopic procedure.

In summary, outbreaks and pseudo-outbreaks associated with endoscopes, including bronchoscopes, continue to occur. When evaluating clusters of patients with the same pathogen isolated from respiratory tract specimens, infection control preventionists should consider the possibility of a bronchoscope-related outbreak or pseudo-outbreak. Pseudo-outbreaks also warrant close attention, as in many instances patients received incorrect diagnoses, delaying the correct diagnosis, and unnecessary treatment, with its potential for adverse events. Meticulous attention to proper cleaning and disinfection of endoscopes is the critical prevention.

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