RESEARCH BRIEFS

Intraoperative Stopcock and Manifold Colonization of Newly Inserted Peripheral Intravenous Catheters

The intraoperative environment of the anesthesiologist presents unique challenges regarding decisions about glove use and hand hygiene in a time-sensitive setting. There has generally been little focus on the role played by the anesthesiologist in device-related infections and surgical site infections in the infection control literature.[1] However, recent studies have found that as many as 1 in 3 catheter stopcocks become contaminated intraoperatively,[2,3] often with microbes colonizing the hands of anesthesiologists[4] and correlating with contamination of anesthesia machine contamination.[2] Stopcock contamination is associated with hospital-acquired infection and phlebitis;[3] it is reduced by improved intraoperative hand hygiene by anesthesiologists,[5] and such contamination is independently associated with mortality.[5] Use of a single pair of gloves by anesthesiologists in the operative environment for an extended duration has been observed.[1] Thus, it is not surprising that a 10-fold increased risk of intraluminal catheter colonization is correlated with glove use in the operating room,[6] which can subsequently be reduced using needleless connectors instead of stopcocks.[3] We conducted a pilot study to assess the likelihood and quantity of intraoperative microbial colonization of peripheral intravenous catheter stopcocks and manifolds. The catheters were placed in the preoperative holding area, and they were the predominant catheter used for intraoperative medication administration by anesthesiology staff. Staff were unaware the study was being conducted. The study was approved by the Institutional Review Board.

Between January 2, 2012, and May 30, 2013, when patients entered the postanesthesia care unit immediately after completion of surgery, catheter manifolds were aseptically removed, placed in sterile containers, and transported to the microbiology laboratory. Study inclusion was based on availability of one of the investigators and was not otherwise randomly determined. In the microbiology laboratory, 160 μL of sterile thioglycolate broth was injected into each catheter manifold and allowed to drip into a sterile centrifuge tube. Each tube was vortexed, and 50 μL of broth was transferred to blood, chocolate, and *Brucella* anaerobic agar plates and incubated for 5 days at 35°C in the appropriate atmospheric conditions. In addition, a flocked swab was moistened with sterile thioglycolate broth, inserted into each stopcock port (1 swab per stopcock, 3 stopcocks per catheter manifold), and then transferred to a tube of thioglycolate broth and incubated for 5 days at 35°C. If the broth was cloudy, it was plated to blood, chocolate, and *Brucella* anaerobic agar plates and incubated as described above. Identification of individual colonies from all plates was determined using Vitek 2 (bioMérieux) and matrix-assisted laser desorption/ionization time-of-flight analysis (Shimadsu and bioMérieux).

The 2-sample t test was used to assess for a relationship between the microbial growth in stopcocks or manifold lumens and duration of surgery or the number of times medications were intraoperatively administered through these catheters.

Twenty-four patients' catheter manifold lumens were flushed and cultured. Each catheter manifold had 3 stopcocks. Seventy stopcocks on those manifolds were cultured; 2 stopcocks could not be cultured. Nine (38%) of 24 manifolds had growth on at least 1 stopcock (Table 1), and 8 of these 9 manifolds had at least 1 stopcock culture with heavy microbial growth (4+ on an agar plate; scale, 1+ to 4+). Individually, 12 (17%) of the 70 stopcock cultures had growth. Ten of these 12 stopcock cultures had at least 1 agar plate with heavy growth. Most microorganisms identified in stopcock cultures were skin flora (Table 1). Two (8%) of 24 manifold lumen flush cultures had growth; both grew coagulase-negative staphylococci. There was no relationship between microbial growth from either the stopcocks or the manifold lumen and duration of surgery ($P = .2$) or the number of times medications were administered through these catheters ($P = .5$).

More than 1 in 3 patients who had catheters inserted intraoperatively had contamination of at least 1 of the 3 stopcocks on their catheter manifold assembly, predominantly with heavy growth of skin flora. Although manifold lumen flush cultures revealed less growth, transient bacteremia from injection into colonized stopcocks may occur. These findings suggest a risk of bacteremia, leading to the possibility of hematogenously seeding implanted devices. We did not find a correlation between contamination and the number of times medications were administered through the stopcocks or duration of surgery, but our study may have been underpowered to reveal such a relationship.

On the basis of our findings, we made the following interventions: present the data to the Department of Anesthesiology, operating room, and preoperative holding staff, including education regarding proper hand hygiene and glove use, the importance of cleaning catheter connectors before and after use, and an open-forum discussion about barriers to hand hygiene and suggested interventions unique to their work environment. We then commenced with an infection control plan that included providing anesthesiology staff with alcohol hand hygiene dispensers that are waist-worn or fit onto their stethoscopes;[7] we removed catheter assemblies with manifolds containing multiple stopcocks from the operating room supplies and replaced them with catheter assemblies that have needleless connectors and port protectors,[3] and we reviewed and revised as needed our policy for cleaning of anesthesiology equipment in the operating rooms, since such equipment has been found to be an important source of contamination.[2] Oth-

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TABLE 1. Patient Characteristics and Microbiologic Culture Results

Patient	Surgery	Surgery duration	No. of times intravenous medications administered	Catheter manifold lumen flush	Catheter stopcock culture	Thioglycolate broth culture results	Gram stain	Identification by Vitek 2	Semi-quantitative colony counts on agar plates	Identification by MALDI-TOF
1	Total knee arthroplasty	2h58min	14	NG	1a	NG				
					1b	NG				
					1c	G	GPR	*Bacillus*	4+	*B. cereus* group
2	Total hip arthroplasty	2h35min	17	NG	2a	NG				
					2b	NG				
					2c	NG				
3	Endovascular repair	3h59min	23	NG	3a	NG				
					3b	G	GNR			NG
					3c	NG				
4	Total hip arthroplasty	2h39min	12	NG	4a	G	GPR	Anaerobic GPR	1+ to 4+	*P. acnes*
					4b	NG				
					4c	NB				
5	Total hip arthroplasty	5h49min	18	STCN	5a	G	GPC	STCN	4+	*S. epidermidis*
					5b	G	GPC	STCN	4+	*S. lugdunensis*
					5c	NG				
6	Total hip arthroplasty	2h35min	25	NG	6a	G	GPR		1+ to 4+	
					6b	NG				
					6c	NG				
7	Total hip arthroplasty	1h31min	15	NG	7a	NG				
					7b	G	GPC	STCN	4+	
					7c	NG				
8	Endovascular repair and bypass	6h14min	33	NG	8a	G	GPC	STCN	4+	*S. epidermidis*
					8b	NG				
					8c	NG				
9	Spinal fusion	4h26min	19	NG	9a	NG				
					9b	NG				
					9c	NG				
10	Total hip arthroplasty	2h26min	16	NG	10a	NG				
					10b	No culture				
					10c	No culture				
11	Total hip arthroplasty	2h39min	19	NG	11a	G	GPR	*P. acnes*	3+	
					11b	NG				
					11c	NG				
12	Total hip arthroplasty	2h33min	15	NG	12a	NG				
					12b	NG				
					12c	NG				
13	Total hip arthroplasty	2h11min	15	NG	13a	NG				
					13b	G	GPC	AHS	3+	*S. parasanguinis*
					13c	G	GPR	*P. acnes*	3+ to 4+	*P. acnes*
14	Total hip arthroplasty	5h14min	20	NG	14a	NG				
					14b	NG				
					14c	NG				
15	Total hip arthroplasty	2h24min	12	NG	15a	NG				
					15b	NG				
					15c	NG				
16	Endovascular repair	3h17min	14	NG	16a	NG				
					16b	NG				
					16c	NG				
17	Total hip arthroplasty	2h22min	15	NG	17a	G	GPC	STCN	4+	*S. capitis*
					17b	NG				
					17c	G	GPC	STCN	4+	*S. capitis*
18	Total hip arthroplasty	2h39min	14	NG	18a	NG				
					18b	NG				
					18c	NG				
19	Total hip arthroplasty	2h42min	21	NG	19a	NG				
					19b	NG				
					19c	NG				

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TABLE 1 (*Continued*)

Patient	Surgery	Surgery duration	No. of times intravenous medications administered	Catheter manifold lumen flush	Catheter stopcock culture	Thioglycolate broth culture results	Gram stain	Identification by Vitek 2	Semi-quantitative colony counts on agar plates	Identification by MALDI-TOF
20	Aortic valve replacement	4h22min	32	NG	20a	NG				
					20b	NG				
					20c	NG				
21	CABG	6h26min	23	NG	21a	NG				
					21b	NG				
					21c	NG				
22	Aortic valve replacement	6h47min	35	NG	22a	NG				
					22b	NG				
					22c	NG				
23	CABG	4h40min	28	*S. epidermidis*	23a	NG				
					23b	NG				
					23c	NG				
24	Aortic valve replacement	5h6min	18	NG	24a	NG				
					24b	NG				
					24c	NG				

NOTE. AHS, α-hemolytic *Streptococcus*; CABG, coronary artery bypass graft; G, growth; GNR, gram-negative rod; GPR, gram-positive rod; MALDI-TOF, matrix-assisted laser desorption/ionization time-of-flight analysis; NG, no growth; STCN, coagulase-negative staphylococci.

ers have utilized comprehensive programs to successfully mitigate the risk of catheter-associated bloodstream infections in the operating room.[8] We hope that our findings will stimulate interest in strategies aimed at minimizing stopcock contamination in the operating room setting.

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L. A. Mermel, DO;[1,2] A. Bert, MD;[3] K. C. Chapin, MD;[2,4] L. LeBlanc, BS[4]

Affiliations: 1. Department of Epidemiology and Infection Control, Rhode Island Hospital, Providence, Rhode Island; 2. Department of Medicine, Warren Alpert Medical School of Brown University, Providence, Rhode Island; 3. Department of Anesthesiology, Rhode Island Hospital, Providence, Rhode Island; 4. Department of Pathology, Rhode Island Hospital, Providence, Rhode Island.

Address correspondence to Leonard Mermel, DO, Division of Infectious Diseases, Rhode Island Hospital, 593 Eddy Street, Providence, RI 02903 (lmermel@lifespan.org).

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Electronic Monitoring of Individual Healthcare Workers' Hand Hygiene Event Rate

Healthcare worker hand hygiene reduces healthcare-associated infections, but compliance is not optimal.[1] Electronic hand hygiene monitoring systems (EMS) provide continuous