CONCISE COMMUNICATION

Randomized Crossover Study Evaluating the Effect of a Hand Sanitizer Dispenser on the Frequency of Hand Hygiene among Anesthesiology Staff in the Operating Room

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Forty anesthesia providers were evaluated with and without hand sanitizer dispensers present on the anesthesia machine. Having a dispenser increased the frequency of hand hygiene only from 0.5 to 0.8 events per hour ($P = .01$). Other concomitant interventions are needed to further increase hand hygiene frequency among anesthesia providers.

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Multidrug-resistant organisms are acquired during acute hospitalizations. The acquisition of these pathogens is clinically significant given that they cause a considerable proportion of hospital-acquired infections.[1] These transmissions are thought to occur in part due to environmental contamination. The operating room (OR) is quite a distinctive area given the high frequency of contacts between healthcare workers' hands, environmental surfaces, patients' body surfaces, and intravascular devices.[2] Furthermore and despite general beliefs, surfaces within the OR, including anesthesia machines, are not adequately disinfected at the end of each working day.[3] Not surprisingly, reports describe horizontal transmission of organisms between consecutive cases performed within the OR.[4]

Previous studies show that hand hygiene frequency among anesthesiologists is quite low.[2,5,6] One of the main barriers cited by anesthesia providers is the lack of hand sanitizer dispensers next to the anesthesia machine (unpublished data). Therefore, we aimed to evaluate the impact of a hand sanitizer dispenser placed on the anesthesia machine on the frequency of hand hygiene among anesthesiology providers while delivering anesthesia in the OR.

METHODS

This was a randomized crossover study performed at a 1,500-bed public teaching hospital in Florida. All observations were done in the main OR ($n = 30$; approximately 12,000 procedures per year). Anesthesia care is provided by anesthesiology house staff and certified registered nurse anesthetists (CRNAs) under direct supervision of attending anesthesiologists. Study subjects were the primary anesthesia providers defined as the person who remained in the OR throughout the case. This project was approved by the Institutional Review Board.

Randomization and blinding. This study randomized subjects to either the intervention (using a hand sanitizer dispenser on the anesthesia machine in addition to the standard wall-mounted dispensers) or the control (presence of wall-mounted hand sanitizer dispensers only). Within 30 days, the same subjects were evaluated again in the opposite allocation. Before the start of the first scheduled surgical case, simple randomization with a random number generator was used to select the OR. Subsequently, the group allocation was determined using electronic files. Each of these electronic files was labeled using consecutive numbers and contained group allocations previously obtained using block randomization. Files were opened in a consecutive fashion and used only once during the study. If the provider was assigned to start with the intervention, then the hand sanitizer dispenser was placed on the anesthesia machine immediately before the start of the case. Providers were blinded to the outcome being evaluated. All observations were voluntary, and nobody refused to be observed.

Observations. To minimize interobserver variability, one individual (Z.P.) performed all observations. The observer entered the OR along with the patient and remained next to the anesthesia provider for up to 120 minutes or until the patient left the OR (whichever occurred first). The observer recorded the provider's demographics, surgery type, and start and end of surgical procedure. The presence of central vascular devices as well as alcohol disinfection of any sort prior to each access were also evaluated.

We collected the time of hand hygiene, product used, and location of the product (dispenser on anesthesia machine, personal hand sanitizer, or routinely positioned wall dispenser). Both donning and removal of gloves were recorded. Access of airways and contact with either blood or urine were documented, as was the subsequent hand disinfection following this contact. Additionally, the distance from the anesthesia machine to the wall-mounted hand sanitizer dispenser in the OR was measured before the onset of each case.

Statistical analysis. Our primary outcome was the frequency of hand hygiene, defined as the number of hand hygiene events per hour of observation. Baseline characteristics of the groups were analyzed using the χ^2 or Fisher exact test (for proportions) and the Student t test (for continuous variables). Number of events was analyzed using proc glimmix, under the assumption of a Poisson distribution and offsetting the counts by the log of the minutes observed. Data were clustered on the basis of the presence or absence of a holder during the observations. We also evaluated the potential interaction of the initial group assignment on hand hygiene frequency. Gender, level of training, distance between the anesthesia machine and wall-mounted hand sanitizer dis-

TABLE 1. Characteristics of Providers at the Time of Randomization and of All Surgical Procedures Observed

	Randomized to start with hand sanitizer dispenser (n = 20)	Randomized to start without hand sanitizer dispenser (n = 20)	Comparison P	Total (n = 40)
Characteristics of providers at time of randomization				
Gender			.723	
Female	6 (30.0)	5 (25.0)		11 (27.5)
Male	14 (70.0)	15 (75.0)		29 (72.5)
Level of training			.92	
CRNA	6 (30.0)	4 (20.0)		10 (25.0)
PGY 2	9 (45.0)	7 (35.0)		16 (40.0)
PGY 3 and 4	5 (25.0)	9 (45.0)		14 (35.0)
	Procedures with hand sanitizer dispenser (n = 40)	Procedures without hand sanitizer dispenser (n = 40)		Total (n = 80)
Characteristics of all surgical procedures				
Surgery type			.919	
Urologic or gynecologic	10 (25.0)	11 (27.5)		21 (26.2)
Intra-abdominal	6 (15.0)	7 (17.5)		13 (16.2)
Spinal surgery	4 (10.0)	6 (15.0)		10 (12.5)
Vascular	5 (12.5)	2 (5.0)		7 (8.8)
Intracranial	4 (10.0)	4 (10.0)		8 (10.0)
Limb surgeries	3 (7.5)	2 (5.0)		5 (6.3)
Ear, nose, and throat	2 (5.0)	4 (10.0)		6 (7.5)
General: hernia, breast, hemorrhoids	3 (7.5)	2 (5.0)		5 (6.3)
Oral maxillary-facial	2 (5.0)	2 (5.0)		4 (5.0)
Pediatric	1 (2.5)	0 (0)		1 (1.2)
Elective procedure			1.000	
Yes	40 (100)	39 (97.5)		79 (98.8)
No	0 (0)	1 (2.5)		1 (1.2)
Laparoscopy			1.000	
Yes	4 (10.0)	5 (12.5)		9 (10.6)
No	36 (90.0)	35 (87.5)		76 (89.4)
Duration of surgery, mean ± SE, minutes	239.6 ± 26.0	250.4 ± 20.4	.745	
Duration of observations, mean ± SE, minutes	106.3 ± 3.4	117.4 ± 5.0	.073	
Percentage of the surgical procedure observed, % ± SE	61.1 ± 4.6	58.2 ± 4.2	.641	
Distance from anesthesia machine to wall dispenser, mean ± SE, meters	2.2 ± 0.2	2.1 ± 0.2	.541	
Percentage of time gloves used, % ± SE	49.0 ± 4.2	58.6 ± 9.0	.335	

NOTE. Data are no. (%), unless otherwise indicated. CRNA, certified registered nurse anesthetist; PGY, postgraduate year; SE, standard error.

TABLE 2. Results of Multivariable Analysis

Variable	Frequency of hand hygiene per hour of observation (mean ± SE)	P	
Hand hygiene dispenser on the anesthesia machine		.017	
Yes	0.84 ± 0.18		
No	0.54 ± 0.12		
Initial group allocation		.404	
Intervention	0.78 ± 0.12		
Control	0.6 ± 0.12		
		CRNA	PGY 2
Level of training/profession			
CRNA	1.38 ± 0.36		
PGY 2	0.3 ± 0.12	.001[a]	
PGY 3 and 4	0.72 ± 0.18	.100[b]	.059[c]
Gender		.120	
Female	0.9 ± 0.24		
Male	0.48 ± 0.12		
Glove use		.998	
Holder	0.006 ± 0.006		
No holder	0.005 ± 0.006		

NOTE. CRNA, certified registered nurse anesthetist; PGY, postgraduate year.
[a] PGY 2 versus CRNA.
[b] PGY 3 and 4 versus CRNA.
[c] PGY 3 and 4 versus PGY 2.

penser, and cumulative glove use (in minutes) during each observation were all factored in the multivariable model. All analyses were performed with SAS version 9.3.

RESULTS

Forty-five providers were randomized but only 40 completed the study (20 per initial allocation), totaling 80 surgical procedures observed (Table 1). A total of 122 hand hygiene events were observed during 157 hours (0.77 events per hour). Gloves were used for a median of 51 minutes per observation (range, 0–2 hours). Having a hand sanitizer dispenser on the anesthesia machine increased the frequency of hand hygiene from 0.5 to 0.8 events per hour ($P = .01$). The majority of hand hygiene events observed among providers allocated to the dispenser were performed using this portable device (61/71 [86%]). Personal hand hygiene dispensers were not used. Results of the multivariable analysis are shown in Table 2. Both dispenser and profession were associated with higher hand hygiene frequency.

During the observations, 425 intravenous ports were accessed, and only 19 (4.5%) were disinfected with alcohol prior to access. There were a total of 121 contacts with airways, and 120 of them occurred with gloves; however, none of them were followed by hand hygiene. Similarly, there were 65 and 13 contacts with either blood and urine, respectively. All these contacts occurred while wearing gloves, and none were followed by hand hygiene.

DISCUSSION

In this study, we found that placing a hand sanitizer dispenser on the anesthesia machine caused a statistically significant increase in the frequency of hand hygiene events while providing anesthesia care. However, despite this statistical significance, the change probably had limited clinical relevance. Additionally, almost all contacts with bodily fluids were not followed by hand hygiene (regardless of dispenser allocation); we believe that glove use might have partially impacted this behavior.

Previous studies outside the OR also found that solely improving accessibility to alcohol hand sanitizer was insufficient to increase hand hygiene compliance.[7] In the OR, use of concomitant interventions have been found to have a positive impact on hand hygiene frequency.[8,9]

The limitations of our study include being a single-center experience. Additionally, we did not evaluate the impact of anesthesiologists on the bacterial contamination of their work area or on clinical outcomes. Also, the impact of hand hygiene compliance among anesthesiology attendings on primary anesthesia providers was not evaluated. As in other studies, our results are expressed in events per hour.[6,9] Given both the high pace and the complex patterns of interactions during anesthesia care in the OR (L. S. Munoz-Price, ICHE, forthcoming), the moments for hand hygiene as per the World Health Organization[10] might not be appropriate in this setting. We believe

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that the ideal frequency and timing of hand hygiene events during anesthesia care in the OR are still unclear.

The interactions of anesthesiologists in the OR between patients, surfaces, and devices are very complex.[2] Initial studies seem to indicate that these behaviors might potentially have an impact on clinical outcomes, not only increasing the acquisition of multidrug-resistant organisms but also hospital-acquired infection rates.[11] Therefore, further research is needed to better understand the determinants of intraoperative anesthesia provider hand hygiene behavior.

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