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Major Article

Sleep safe in clean hands: Improving hand hygiene compliance in the operating room through education and increased access to hand hygiene products

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Key Words:
Anesthesia
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Background: Hand hygiene compliance is low among anesthesia providers in the operating room, which places patients at risk of preventable infections. The goal of this project was to improve hand hygiene compliance by educating anesthesia providers on the World Health Organization's 5 indications for hand hygiene, and increasing access to hand hygiene products in the operating room.

Methods: Observations of hand hygiene in the operating room took place in 3 phases: preimplementation, postimplementation, and 60 days postimplementation.

Results: The results showed significant improvements in compliance for each of the 5 indications for hand hygiene as well as overall compliance. Each of the 3 phases of anesthesia demonstrated significant improvement as well. The results also showed a significant decrease in both glove use and use of the portable hand sanitizer device.

Discussion: Education and monitoring of hand hygiene among anesthesia providers in the operating room can improve hand hygiene compliance.

Conclusions: Although the use of the portable device declined, further studies could focus on observing single anesthesia providers instead of a preceptor/student combination, and also examine proximity to hand hygiene products in relation to compliance.

In the mid-1800s, researchers determined that hospital-acquired infections were definitely transmitted via the hands of health care workers.[1] One of the researchers, Ignaz Semmelweis, recommended that hands be scrubbed with a chlorinated lime solution before every patient contact.[1] After implementation of this hand hygiene intervention in an obstetric clinic at the University of Vienna Allgemeine Krankenhaus, the maternal mortality rate (mostly due to puerperal fever) decreased from 16%-3% and remained low thereafter.[1]

The World Health Organization (WHO) recommends 5 hand hygiene moments: before patient contact, before aseptic tasks, after body fluid exposure risk, after patient contact, and after contact with patient surroundings.[2] In the operating room (OR), anesthesia providers, such as certified registered nurse anesthetists (CRNAs), engage in frequent patient contact, perform many aseptic and sterile tasks, are exposed to body fluids, and remain in close proximity to the patient throughout the surgical procedure. Thus, anesthesia providers encounter multiple opportunities for hand hygiene.

Despite over a century's worth of knowledge concerning the benefits of handwashing in preventing the spread of infection, hand hygiene compliance remains a problem among anesthesia providers. For example, Megeus et al[3] collected observational data on hand hygiene during anesthetic care in 94 surgical procedures of various surgical specialties. Results showed an overall adherence of 5.3%, with the lowest rate of adherence during the induction phase before an aseptic task (2.2%) and the highest during full-length surgeries after body fluid exposure (15.9%).[3] Similarly, a study by Biddle and Shah[4] observed approximately 8,000 hand hygiene opportunities in anesthesia providers throughout the perioperative period. The results confirmed poor compliance, with an overall failure of hand hygiene of 64%-93%.[4]

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The results from these studies demonstrate that hand hygiene noncompliance in anesthesia providers is a serious problem. The frequent interactions between anesthesia provider, patient, and patient surroundings—in the absence of hand hygiene—increase the risk of microbial transmission and health care–acquired infections.[5] In fact, multidrug-resistant bacteria can be transmitted to objects touched by the contaminated hands or gloves of the anesthesia provider.[6]

Noncompliance with hand hygiene can contribute to patient mortality, extended hospital stays, higher readmission rates, and lower reimbursements for hospitals under the Patient Protection and Affordable Care Act.[7] Furthermore, the consequences for the patient may manifest as bloodstream infections, local injection site infections, abscesses, meningitis, respiratory tract infections, and surgical site infections.[8] Interventions to increase compliance must be implemented to protect vulnerable patients under anesthesia from the spread of germs due to contaminated hands. Thus, the need to maintain patient safety, promote positive patient outcomes, and avoid health care costs makes implementing evidence-based interventions imperative.

The evidence points to the importance of education in effectively improving hand hygiene compliance among anesthesia providers.[9] Education focusing on workflow improvements and reducing avoidable hand hygiene opportunities (eg, recontamination after performing hand hygiene) can increase hand hygiene compliance by 540%.[10] Anesthesia providers also rarely perform hand hygiene after glove removal and fail to use gloves when indicated, for example, when inserting venous lines or performing respiratory care.[11,12] Thus, education on proper hand hygiene and proper glove use can decrease the number of hand hygiene opportunities by 42% and subsequently improve compliance.[10]

The evidence also indicates that increased access to hand hygiene products is effective in improving hand hygiene compliance among anesthesia providers.[12] Increased access to hand hygiene products can be in the form of a hand hygiene device worn on the body or placement of a portable hand hygiene device on the anesthesia machine.[12-14] Hand hygiene devices worn on the body can increase hand hygiene 50%-70%.[13,14] Correspondingly, portable devices can increase hand hygiene from 0.5-0.8 events per hour, with the majority (86%) of hand hygiene events occurring with the use of the portable device.[12]

METHODS

Specific aims

The purpose of this project was to improve hand hygiene compliance among anesthesia providers in the OR through education and increased access to hand hygiene products. The project aims were (1) to provide education to anesthesia providers at a university-affiliated community hospital in the Southeastern United States on the benefits of proper hand hygiene in the OR, (2) to increase anesthesia provider access to hand hygiene products by ensuring that every OR had a portable hand sanitizer dispenser placed on the anesthesia gas machine (in addition to a hand sanitizer mounted on the medication cart), (3) to increase hand hygiene compliance among anesthesia providers from baseline, and (4) to sustain increases in hand hygiene compliance for 60 days after the intervention period.

Context

The project took place in the hospital's main ORs. Anesthesia providers were observed during a wide variety of surgical procedures (eg, orthopedic, thoracic, gynecologic, otolaryngic, neurologic, general). Anesthesia techniques employed were general, regional, and monitored anesthesia care. The population of anesthesia providers included a total of 32 CRNAs, 2 anesthesiologist assistants (AAs), 12 anesthesiologists, 6 anesthesia technicians, and up to 8 student registered nurse anesthetists (SRNAs) from 2 different anesthesia programs.

Observations of anesthesia providers' hand hygiene compliance were recorded per a modified version of the "5 moments for hand hygiene" WHO observation tool, which included a place to record the hand hygiene indication, such as "before patient contact."[2] For each hand hygiene indication, the hand hygiene action was recorded as either a handrub with the hand sanitizer or missed. If hand hygiene was missed, but the provider was wearing gloves, glove use was noted as the hand hygiene action.

Modifications to the WHO observation tool included removing handwashing and replacing it with handrub as the hand hygiene action because sinks were not available inside the OR. Additional modifications included recording the hand sanitizer dispenser used by the provider (ie, the portable device or device mounted to the medication cart) and the phase of anesthesia in which the hand hygiene indications occurred—induction, maintenance, or emergence. Induction was defined as the time the anesthesia provider entered the OR with the patient to the time anesthesia was ready, which was the time surgery could begin; maintenance was defined as the time anesthesia was ready to surgeon closing; and emergence was defined as surgeon closing to the moment the anesthesia provider and patient left the OR. The professional category of the anesthesia provider was also recorded and included CRNA, SRNA, AA, anesthesiologist, and anesthesia technician.

Interventions

The project followed a pre-post test design. Prior to implementation of a comprehensive educational module on hand hygiene for anesthesia providers and increasing access to hand hygiene products, data were collected using the modified WHO hand hygiene observation tool to evaluate baseline hand hygiene compliance among anesthesia providers in the OR. A convenience sample of anesthesia providers delivering anesthesia in the hospital's main ORs was included in the project. Prior to each day of observation, ORs were selected by drawing a number out of a hat. If data on the primary anesthesia provider (defined as the provider assigned to the surgical case) had already been collected, the next randomly selected OR with an unobserved anesthesia provider was chosen. The same anesthesia providers may have been included in the pre- and postimplementation samples, but the groups did not match exactly.

The evidence-based interventions involved educating the anesthesia providers on hand hygiene and increasing access to hand hygiene products using recommendations from "A guide to the implementation of the WHO multimodal hand hygiene improvement strategy."[15] The education included results from baseline data collected during the preimplementation phase, evidence from previous studies revealing poor compliance among anesthesia providers, data on anesthesia work area contamination, information on patterns of transmission of health care–associated pathogens, information about the impact and burden of health care–acquired infections, and procedures for proper hand hygiene and glove use.[15] The goal of the education intervention was 2-fold: to educate and motivate anesthesia providers to improve hand hygiene compliance.

For the portion of the intervention aimed at increasing access to hand hygiene products, each OR was stocked daily with a portable hand sanitizer dispenser placed on the anesthesia gas machine. There were no safety concerns with the addition of the portable hand sanitizer dispenser because it could be easily moved to the most suitable position by the individual anesthesia provider. At baseline, the only hand sanitizer dispenser convenient to the anesthesia provider in the OR was mounted to the side of the medication cart.

Table 1
Hand hygiene compliance by indication

Hand hygiene indication	Preimplementation (%)	Postimplementation (%)	60 days postimplementation (%)	χ^2	*df*	*P* value
Before patient contact	0_a (0)	7_b (16.3)	2_{ab} (5.6)	8.88	2	.012
Before aseptic task	0_a (0)	5_b (8.1)	10_b (9.9)	11.25	2	.004
After body fluid exposure risk	1_a (1.6)	17_b (36.2)	17_b (41.5)	28.65	2	<.001
After patient contact	2_a (3.4)	34_b (63)	25_b (49)	47.26	2	<.001
After contact with patient surroundings	3_a (1.9)	123_b (54.4)	110_b (53.9)	130.00	2	<.001

NOTE. Subscript letters that are different across rows indicate significant differences between time points.
df, degree of freedom.

One week after all anesthesia providers received the education intervention and were aware of the increased access to hand hygiene products, postimplementation observations were conducted in the same manner as the preimplementation observations. The CRNAs were responsible for sharing the information about the interventions with the SRNAs since the population of SRNAs varied from day to day. Approximately 60 days after the initial postimplementation observations, a second week of observations was collected to assess sustainability of the project.

Analysis

Based on a medium effect size (0.30), power set to 90%, and α set to 0.05, a sample size of at least 141 hand hygiene opportunities was estimated in G*Power (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany) to achieve statistical significance.

Data were analyzed using the SPSS Statistics Standard GradPack 24 (International Business Machines Corporation, Armonk, NY) software package, and χ^2 tests with pairwise z-tests were conducted to determine whether there was a difference in hand hygiene compliance across 3 phases: preimplementation, postimplementation, and 60 days postimplementation. Tests were conducted for multiple outcome measures, including overall hand hygiene compliance; hand hygiene compliance according to each of the 5 WHO-defined hand hygiene indications; hand hygiene compliance during the 3 phases of anesthesia; hand hygiene compliance according to professional category, with CRNAs and AAs combined into 1 group; missed hand hygiene opportunity and glove use; and use of portable hand hygiene dispenser.

Ethical considerations

No protected health information or patient information was collected. Hand hygiene observations were collected on paper and transferred into a spreadsheet program (Microsoft Excel; Microsoft Inc., Redmond, WA). The data were stored on a password-protected computer, and only the project committee had access to the data.

RESULTS

The final sample included a total of 1,301 indications for hand hygiene, with 436 in the preimplementation phase, 432 in the postimplementation phase, and 433 in the 60 days postimplementation phase. The overall compliance with hand hygiene was 1.4% preimplementation (n = 6), 43.1% postimplementation (n = 186), and 37.9% 60 days postimplementation (n = 164). A comparison of differences in overall compliance with each of the 5 moments of hand hygiene demonstrated a statistically significant increase in hand hygiene compliance from the preimplementation phase to the postimplementation phase, and this was sustained 60 days postimplementation ($\chi^2[2, N = 1,301] = 22.74, P < .001$).

The comparison of differences for each of the 5 hand hygiene indications showed a significant increase preimplementation to postimplementation that was sustained 60 days postimplementation. Specific changes in each phase of the quality improvement project (according to the 5 hand hygiene indications) can be seen in Table 1.

For all 3 phases of anesthesia (induction, maintenance, emergence), there was a significant increase from preimplementation to postimplementation and a nonsignificant decrease from postimplementation to 60 days postimplementation. Results are displayed in Table 2.

Table 3 displays hand hygiene compliance according to professional category. For CRNAs and AAs, there was a significant increase preimplementation to postimplementation that was sustained 60 days postimplementation. There was a significant increase preimplementation to postimplementation and a significant decrease postimplementation to 60 days postimplementation for SRNAs. Although hand hygiene compliance increased among anesthesiologists and anesthesia technicians, the increase was not significant.

When participants were not compliant with hand hygiene, gloves were worn 52.3% (n = 225) of the time preimplementation, 37.2% (n = 92) of the time postimplementation, and 43.5% (n = 117) of the time 60 days postimplementation. These results represented a significant decrease from preimplementation to postimplementation that was sustained 60 days postimplementation ($\chi^2[2, N = 946] = 15.23, P < .001$).

When hand hygiene was performed, the portable device was used 22.7% (n = 42) of the time postimplementation and 14.0% (n = 23) of the time 60 days postimplementation. These results represented a significant decrease in the use of the portable device ($\chi^2[1, N = 349] = 4.32, P = .038$).

In evaluating professional categories, overall hand hygiene compliance was 32.1% (n = 284) for CRNAs and AAs, 18.6% (n = 65) for SRNAs, 8.9% (n = 5) for anesthesiologists, and 18.2% (n = 2) for anesthesia technicians.

Table 2
Hand hygiene compliance by phase of anesthesia

Phase of anesthesia	Preimplementation (%)	Postimplementation (%)	60 days postimplementation (%)	χ^2	*df*	*P* value
Induction	0_a (0)	11_b (22.4)	3_{ab} (7.9)	17.14	2	<.001
Maintenance	5_a (1.6)	164_b (46.9)	143_b (44.1)	192.13	2	<.001
Emergence	1_a (1.8)	11_b (34.4)	18_b (25.4)	17.65	2	<.001

NOTE. Subscript letters that are different across rows indicate significant differences between time points.
df, degree of freedom.

Table 3
Hand hygiene compliance by professional category

Professional category	Preimplementation (%)	Postimplementation (%)	60 days postimplementation (%)	χ^2	*df*	*P* value
CRNA & AA	3_a (1.1)	153_b (45.5)	128_b (46.5)	175.03	2	<.001
SRNA	3_a (2.2)	30_b (40.0)	32_c (23.2)	48.70	2	<.001
Anesthesiologist	0_a (0)	3_a (15)	2_a (14.3)	3.56	2	.169
Technician	0_a (0)	0_a (0)	2_a (33.3)	2.04	2	.361

NOTE. Subscript letters that are different across rows indicate significant differences between time points.
AA, anesthesiologist assistants; *CRNA*, certified registered nurse anesthetists; *df*, degree of freedom; *SRNA*, student registered nurse anesthetists.

DISCUSSION

The preimplementation results reveal very low compliance with hand hygiene among anesthesia providers in the OR. These results are similar to those found by Rowlands et al,[16] who reported that anesthesia providers are least likely to follow WHO hand hygiene guidelines before patient contact. Furthermore, there was 0% compliance during induction, 1.6% compliance during maintenance, and 1.8% compliance during emergence. This coincides with the findings of Megeus et al,[3] which showed the lowest compliance with hand hygiene during induction at 3.1%.

The anesthesia providers at this hospital work in an anesthesia care team model with a ratio of anesthesiologists to CRNAs and AAs of 1:4. The anesthesiologist for each case was present during induction and emergence and other critical portions of the case but did not remain in the OR for the entire case. The anesthesia technicians are rarely involved in patient care. Thus, the small sample size leading to nonsignificant results for anesthesiologists and anesthesia technicians was not surprising.

The professional category results combined CRNAs and AAs because there were only 2 AAs on staff. CRNAs precept SRNAs and remain with the student in the OR throughout the case. The CRNA serving as a preceptor has a direct impact on student development.[17] The significant decrease in compliance of SRNAs from postimplementation to 60 days postimplementation strongly suggests that CRNAs must continually reinforce hand hygiene compliance with each SRNA they precept.

Interestingly, the use of gloves significantly decreased and sustained. This result can be attributed to the increase in hand hygiene, a finding that is supported by a study demonstrating an indirect relationship between the use of hand hygiene and glove use.[18] Furthermore, 1 CRNA stated, "I don't wash before gloves because gloves won't go on." Another CRNA stated, "It's hard to do hand hygiene before gloves." One author (E.T.P.) also observed a CRNA clean his gloves with a disinfecting wipe instead of performing hand hygiene. Further research could focus on the effectiveness of glove cleaning in place of hand hygiene to improve compliance and patient safety.

The results regarding the use of the portable device also showed a significant decrease from postimplementation to 60 days postimplementation. These results may be due to a lack of leadership, as evidenced by staff noncompliance with restocking of the portable device. Liber et al[19] found that leadership may play a key role in sustaining hand hygiene adherence because hand hygiene declines when advocates are no longer in leadership positions. Additionally, it was noted that when a CRNA and SRNA were observed, 1 person used the portable device and the other used the mounted device; this may have contributed to the frequency of portable device use. Thus, further research on proximity to the hand sanitizer dispenser may be useful.

Hand hygiene is a continuous process improvement and requires sustained support from clinical leaders. This quality improvement project reveals that education and periodic observation of hand hygiene practices can improve compliance. Although the implementation of the portable device did not prove to increase compliance, further research could focus on portable device use when only 1 anesthesia provider is present for the case instead of a CRNA and SRNA sharing a small workspace. In addition, nurse anesthesia programs could incorporate hand hygiene education through the use of simulation, as simulation can provide the realism of clinical situations without risking patient safety.[20]

CONCLUSIONS

Hand hygiene must transform from a task into a habit. Gardner[21] defines a habit as a process by which a stimulus generates an impulse to act as a result of a learned stimulus-response association. The WHO 5 moments for hand hygiene must become the learned stimulus, and the use of the hand sanitizer in the OR must be the response.[22]

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