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NEWSLETTER
THE OFFICIAL JOURNAL OF THE ANESTHESIA PATIENT SAFETY FOUNDATION

CITATION: Charnin JE, Hollidge M, Bartz R, et al. A best practice for anesthesia work area infection control measures: what are you waiting for? *APSF Newsletter.* 2022;37:103–106.

A Best Practice for Anesthesia Work Area Infection Control Measures: What Are You Waiting For?

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INTRODUCTION

Infection prevention is of paramount importance for anesthesia professionals in 2022 given emerging infectious diseases such as COVID-19,[1] Monkeypox,[2] *Candida auris,*[3] and the persistent nature of surgical site infections (SSIs) associated with increased patient morbidity and mortality.[4-6] Further, as any infection can lead to sepsis, infection prevention is sepsis prevention.[7] Evidence-based basic perioperative infection control measures for the anesthesia work area are of proven efficacy for viral[8] and bacterial pathogens, generating substantial reductions in pathogen transmission and subsequent infection.[8-10] It is time for anesthesia professionals, who have always been leaders in patient safety, to leverage the solid platform of published evidence to improve the safety of our patients through infection prevention.[11]

In this review we highlight important implementation features for basic preventive measures with few perceived barriers for implementation. These approaches are based on both current literature and pertinent infection control guidelines (Society for Healthcare Epidemiology of America [SHEA],[12] Association for Professionals in Infection Control [APIC],[13] Centers for Disease Control and Infection Prevention [CDC],[14] American Society of Anesthesiologists [ASA],[15] and the American Association of Nurse Anesthesiology [AANA][16]). We describe four pillars of perioperative infection control measures applicable to all perioperative providers including patient decolonization, hand hygiene, vascular care, and environmental cleaning optimized by monitoring and feedback.[8,12]

The recommended interventions represent best practices designed to address the primary routes of infection that include 1) direct contamination of the wound, 2) contiguous spread following patient skin contamination occurring as a result of existing colonization or colonization resulting from patient care, 3) aerosolization of particles contaminated by pathogens arising from various anesthesia work area reservoirs such as contaminated environmental surfaces/equipment, and 4) hematogenous spread occurring as a result of injection of bacterial pathogens via injection port, syringe tip, and/or medication vial contamination.[17] Importantly, these recommendations are cost-effective,[18] practical,[9] and with confirmed implementation feasibility.[10]

Figure 1: Evidence-based high-value opportunities to mitigate transmission of infection across the perioperative continuum.

While each of these preventive measures may sound familiar, and it may initially seem that you and your colleagues are already employing these practices, please carefully consider the implementation features of each recommendation. Using the right "dose" of the intervention is important to obtain the benefits for your patients.[8-10,19] Figure 1 is an infographic that was developed to depict how infection prevention extends across the perioperative continuum. A multifaceted approach involving patient decolonization, hand hygiene, vascular care, and environmental cleaning improvement efforts implemented in parallel during the process of patient care and optimized by feedback is supported by rigorous study of the perioperative epidemiology of bacterial transmission,[20-24] and of proven efficacy.[8-10] However, single interventions, such as hand hygiene,[25,26] patient decolonization,[27] or environmental cleaning[28] without feedback optimization are prone to failure.

PATIENT DECOLONIZATION:

Recommendations:

1. Two doses of 5% nasal povidone iodine within one hour of the surgical incision[8,29] and use of 2% chlorhexidine gluconate wipes on the morning of surgery.[8,10,30]

   OR

2. At least 2 days of treatment (ideally the day before and the day of surgery) with 5% nasal mupirocin ointment with 2% chlorhexidine gluconate wipes or 4% shampoo.[30-32]

3. Prescribe post-discharge decolonization for your patients colonized with *methicillin-resistant Staphylococcus aureus* (MRSA) as a result of the health care exposure.[32]

Rationale: The epidemiology of perioperative *S. aureus* transmission involves pathogen colonization of patient skin sites (nares, axilla, and/or groin).[8,10,33-35] Postoperative infection development is strongly tied to *S. aureus* colonization at these sites.[20,34,35] As stated in recommendations 1 and 2 above, decolonization of patient skin sites reduces surgical site infections.[8,10,30-32] The optimal timing of decolonization interventions still requires more research. Postoperative decolonization of patients colonized with MRSA occurring as a result of the health care exposure can significantly decrease the risk of invasive infection development up to one year following the health care exposure.[32] Prevention of perioperative transmission resulting in colonization can augment the latter.[8,10]

Key Implementation Features: Choice of decolonization agent is important with increasing antibiotic resistance associated with an increase

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in worldwide mortality.[36,37] Both iodine and mupirocin are efficacious for SSI prevention.[29-31] Nasal mupirocin has been associated to some degree with increasing resistance,[38] whereas iodine has not.[39,40] Iodine can be managed preoperatively by the anesthesia professional with two doses given prior to incision.[8,29] whereas nasal mupirocin requires 2–5 days of treatment.[30,31] Specific monitoring of patient and provider compliance with prescribed decolonization components is important. Targeted feedback to providers and monitoring of expected utilization of decolonization supplies are also important.[8,10]

HAND HYGIENE

Recommendations:

1. Increase hand hygiene frequency during anesthesia care. Perform hand hygiene at least 8 times per hour[41] during anesthesia care and at least 4 times per hour while providing care in critical care environments.[42]
2. Improve the frequency and quality of environmental cleaning to aid hand hygiene improvement efforts.[8-10,43,44]

Rationale: Contact with the operating room environment is frequent and fast-paced during the provision of anesthesia care, often involving simultaneous touching of the patient and the environment/equipment.[45] Given the demonstrated link between hand and environmental reservoirs,[41] improved hand hygiene can reduce potential environmental infectious transmission events.[41,43,46] Ideally, hand hygiene is performed before and after patient contact, after bodily fluid exposure, after contact with the contaminated environment, and before performing a clean/aseptic task:[41,47] These are the "5 Moments of Hand Hygiene" described by the World Health Organization (WHO). During anesthesia care, hand hygiene must be performed frequently and thoughtfully to capture as many opportunities to reduce the transmission of pathogens as possible. While it may not be possible to perform hand hygiene after every event identified by the WHO guidelines, anesthesia professionals must do more to reduce the transmission of pathogens in the operating room. Inferred from published data, performing hand hygiene at least eight times hourly would significantly reduce potential transmission events.[41] In a related step, more frequent and better-quality environmental cleaning can reduce the potential for transmission events associated with hand contamination.[8,10,41,43,46] Double gloving during induction may augment WHO-based hand hygiene efforts, but further clinical study is indicated before adoption given only simulated environmental testing of this approach.[45]

Key Implementation features: It is important to have hand sanitizers stationed in easy reach of intraoperative providers, including ideally in several places around the anesthesia work area, to facilitate use during fast-paced patient care.[41,43,44] Consider placing alcohol-based hand sanitizers on the anesthesia machine, mounted to the intravenous pole[8,10] and on the provider waist.[41] The importance of hand hygiene is not limited to anesthesia team members. All members of the perioperative team (i.e., circulating nurses, scrub technologists, surgeons, clinical anesthesia technologists, trainees, and equipment representatives) should employ the recommended measures when providing perioperative patient care.

VASCULAR CARE

Recommendations:

1. Disinfect injection ports, using 70–90% isopropyl alcohol prior to access. We suggest hard scrubbing to create friction for 5–30 seconds followed by drying.[48-53] If using caps designed to clean needleless connectors, use products proven to be effective and follow manufacturer recommendations. Some of these devices require at least 10 seconds of contact time to be effective.[49]
2. Avoid use of open lumens (e.g., uncovered stopcocks) as they are at increased risk of contamination, cannot be disinfected well once contaminated,[50] and contamination has been repeatedly associated with increased patient mortality.[20,52]
3. Clean all medication vials with an alcohol wipe after the dust cover is removed from the vial and prior to access to prevent contamination and infection.[53] Keep injection ports, syringe tips, and IV tubing off the floor.[49]

Rationale: Injection ports and medication vials should be disinfected by scrubbing with a 70–90% isopropyl alcohol swab prior to each connection.[8,10] While there is no consensus for duration of injection port scrubbing with ethanol swabs, we recommend a total time of 5–30 seconds with hard rubbing to create friction followed by air drying.[48-53] Scrubbing in this manner followed by 30 seconds of drying time was shown to eliminate injection of bacteria from anesthesia professional hands in a randomized *ex vivo* study.[48]

Research has shown that up to 50,000 colony forming units of live bacteria are injected into the intravenous (IV) fluid pathway as a result of breaches in good vascular access aseptic practice as described above.[48] This is a primary route of surgical site and blood stream infection development[54] which can increase patient mortality severalfold.[55] Importantly, intraoperative stopcock contamination has been repeatedly associated with increased patient mortality and directly linked by advanced molecular typing to postoperative infection development.[20,56] Randomized controlled clinical trials at several centers[41] have shown that improved vascular care through use of injection ports with disinfecting caps mounted to the IV pole can generate substantial reductions in pathogen transmission and infectious complications. With recent confirmation of intraoperative contamination of a patient

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intravenous stopcock with SARS-CoV-2,[9] the importance of these recommendations extends beyond bacterial pathogens.

Key Implementation Features: Have alcohol pads and alcohol disinfecting caps close to providers, allowing easy access to disinfection tools.[44] Use an appropriate disinfection time for each method of disinfection.[48-50]

ENVIRONMENTAL CLEANING

Recommendations:

1. Implement postinduction/sedation cleaning using a 2-hit approach involving wipes containing at least one alcohol and a quaternary ammonium compound.[43,46] Use microfiber cloth to increase removal of the bioburden.[28]
2. Organize the environment into clean/dirty spaces.[46]
3. Augment surface disinfection cleaning with ultraviolet irradiation with proven efficacy, effectiveness, and implementation feasibility.[9] Use monitoring for targeted implementation of more advanced cleaning procedures.[10,21,57]

Rationale: Perioperative environmental cleaning is multifaceted, involving routine, between-case cleaning, and terminal cleaning. Environmental contamination peaks during induction and emergence of anesthesia, periods of patient care that correlate with nadirs in hand hygiene compliance.[43] The anesthesia work area environment, represented by the adjustable pressure-limiting valve and agent dial of the anesthesia machine, is a potent transmission vehicle with transmission events directly linked to infection development.[20,53] At least 50% of *S aureus* SSIs can be linked to ≥1 anesthesia work area reservoir at the time of the surgery.[21] In a study performed at Dartmouth Hitchcock Medical Center, postinduction cleaning, organization of clean/dirty spaces, use of microfiber cloths, and use of multimodal surface disinfection wipes was associated with a significant reduction in the number of measured reservoirs exceeding 100 CFU per surface area sampled,[46] a threshold of contamination associated with high-risk transmission events subsequently linked to infection.[8,10,20,56] These results were similar to a well-designed crossover trial in the ICU environment where increased frequency of cleaning and use of microfiber cloths reduced bacterial contamination.[28] When ultraviolet C light (UV-C) is employed as part of an evidence-based, multifaceted approach (including improved frequency and quality of surface disinfection environmental cleaning and augmentation with UV-C, patient decolonization, vascular care, and hand hygiene), substantial reductions in *S. aureus* transmission, SARS-CoV-2 transmission, and SSIs can be achieved.[9]

Key Implementation Features: Employ postinduction/sedation cleaning to address an important peak in environmental contamination, organize clean/dirty spaces,[43,46] and augment surface disinfection cleaning with use of evidence-based UV-C.[8-10,58] It is important that UV-C devices selected take into account the importance of operating room time,[59] that implementation strategies have been delineated, and that they are of proven efficacy for prevention of intraoperative transmission of bacterial and viral pathogens.

CONCLUSION

Anesthesia teams are well positioned to work collaboratively with the perioperative surgical/nursing team to maximally attenuate perioperative bacterial transmission and subsequent infection. The basic infection control measures have been developed and rigorously tested with proven efficacy, effectiveness, and implementation feasibility and practicality. It is up to anesthesia professionals to act on this information to improve perioperative patient safety.

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Conflicts of Interest: Randy Loftus, MD, reports current research funding from NIH R01 AI155752-01A1, "BASIC trial: Improving implementation of evidence-based approaches and surveillance to prevent bacterial transmission and infection" and has received funding from the Anesthesia Patient Safety Foundation, Sage Medical Inc., BBraun, Draeger, Surfacide, and Kenall, has one or more patents pending, is a partner of RDB Bioinformatics, LLC, and 1055 N 115th St #301, Omaha, NE 68154, a company that owns OR PathTrac, and has spoken at educational meetings sponsored by Kenall and BBraun. The University of Iowa uses RDB Bioinformatics PathTrac system for measuring bacterial transmission.

Jonathan Tan, MD, MPH, MBI, FASA, receives research grant funding from the Anesthesia Patient Safety Foundation (APSF) and the Foundation for Anesthesia Education and Research (FAER).

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Desiree Chappell, CRNA, is on the Speakers Bureau for Medtronic and Edwards LifeSciences, and the Advisory Board for ProVation.

Jonathan Charnin, Melanie Hollidge, Raquel Bartz, Morgan Hellman, Sarah McMannus, Richard Beers, and Michelle Beam report no conflicts of interest.

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