American Journal of Infection Control 42 (2014) 698-701

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major article

Video observation to map hand contact and bacterial transmission in operating rooms

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Key Words:
Hand hygiene
Health care-associated infection
Equipment contamination

Background: Hand hygiene (HH) is considered a primary intervention to avoid transmission of bacteria in health care settings and to prevent health care-associated infections. Despite efforts to decrease the incidence of health care-associated infections by improving HH, HH compliance rates vary widely depending on the hospital environment.

Methods: We used intraoperative video observation to map temporal patterns of anesthesia provider hand contact with anesthesia work environment (AWE) surfaces and to assess HH compliance. Serial bacterial cultures of high contact objects were subsequently used to characterize bacterial transmission over time.

Results: Using World Health Organization criteria, we found a large number of HH opportunities and a low rate of HH compliance by anesthesia providers (mean, 2.9%). We observed an inverse correlation between provider hand hygiene compliance during induction and emergence from anesthesia (3.2% and 4.1%, respectively) and the magnitude of AWE surface contamination (103 and 147 CFU, respectively) at these time points. We found no correlation between frequency of hand contact with the AWE and bacterial contamination.

Conclusions: Compliance with current HH recommendations by anesthesia providers is not feasible. However, there does appear to be a correlation between HH compliance rates and bacterial contamination of the AWE, an observation that should stimulate further work to design new methods for control of bacterial transmission in operating rooms.

Health care-associated infections (HCAIs) occur frequently, are associated with a significant increase in patient morbidity and mortality, and are considered by most researchers to be largely preventable.[1-4] Infections that occur after elective surgery account for a significant proportion of all HCAIs.[2,3,5] In recent studies, we have shown that multiple bacterial reservoirs contribute to bacterial transmission events in operating rooms (ORs) and that residual contamination of representatives of the anesthesia environment often link patient and provider bacterial reservoirs in part through hand contact.[6-10] Furthermore, residual contamination of the environment could lead to aerosolization of bacteria during patient care.[11] Consequently, further work is needed to characterize the process of OR environmental contamination so improved strategies can be developed to prevent bacterial transmission events in ORs. In our investigation, we used video observation and serial environmental surface cultures to characterize anesthesia work area (AWE) environmental contamination over time during routine administration of general anesthesia. We hypothesized that bacterial contamination of AWEs would correlate with frequency of touch by providers, correlate with frequency of hand hygiene (HH) compliance, and continually increase throughout the routine administration of general anesthesia.

METHODS

Following institutional review board review a waiver for informed, written consent was obtained from each study

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Conflicts of interest: None to report.

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http://dx.doi.org/10.1016/j.ajic.2014.02.021

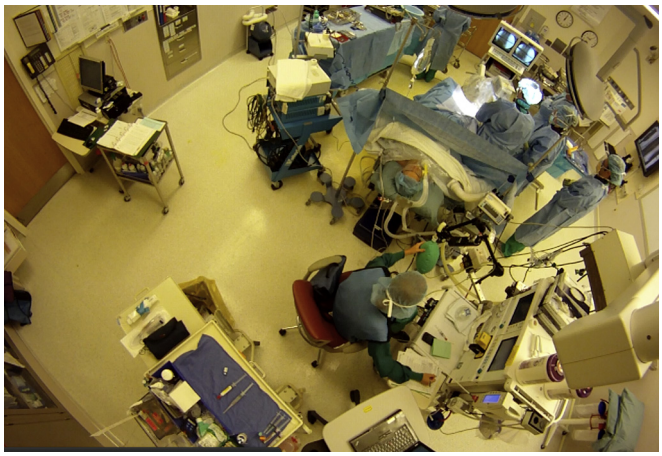

Fig 1. View of anesthesia work environment from the video recording camera.

participant. Verbal consent was obtained following patient review of an institutional review board-approved handout.

Methodology for video analysis of high contact objects and HH compliance

There were 2 phases to our study, each included 5 surgical cases. During the first study phase, 5 randomly selected operating rooms scheduled for surgery that required general anesthesia with airway manipulation (endotracheal tube or laryngeal mask airway) were observed using a commercially available video camera (GoPro HD Hero; Woodman Labs, Inc, Half Moon Bay, Calif) discretely mounted on a wall near the AWE (defined as the area behind the surgical drape). Patient entry to and departure from the AWE triggered the onset and termination of video observation, respectively. Video was recorded onto an secure digital high capacity memory card, then transferred to an external hard drive for later analysis. The camera was mounted to obtain a wide-angle view of the entire AWE (Fig 1).

Identification of frequently touched objects (study phase 1)

Hand contact interactions (gloved or ungloved) between anesthesia provider hands and 90 different objects within the AWE were observed and quantified during sequential 20-minute time epochs. Although providers were blinded to observational end points, observation was voluntary and no providers refused to participate. They were aware, however, of the recording. Event capture was maximized by the angle of the camera and its location, which made it possible to easily identify video-observable triggers; observe subsequent or preceding behaviors; and to code for HH opportunity events in a straightforward, standardized manner. Because no assumptions were needed about the cognition behind an observable behavior we were able to code each event in a simple, standard way. Review of these first 5 videos quantified all interactions and allowed identification of the 20 most frequently touched objects in the AWE.

Observation of HH compliance

Opportunity-based HH compliance of providers with World Health Organization criteria[12] was recorded concurrently during the first phase of the study. Events were independently quantified by 3 individuals who were experienced in OR provider responsibilities and procedures (ie, attending anesthesiologist, senior anesthesiology resident, and operating room nurse) and data are presented as the mean number of events. One hand decontamination event was defined as use of either a wall-mounted alcohol-based gel dispenser or a 70% ethanol liquid dispenser. Each operating room had both a wall-mounted alcohol-based gel dispenser located within 3 steps of the anesthesia provider and a 70% ethanol liquid dispenser on the anesthesia cart.

Table 1
The 20 most frequently touched objects in the anesthesia work environment, tabulated for 5 operative procedures that required general anesthesia with airway manipulation

Object	Mean touches per hour
Patient bed	77
Pen	63
Anesthesia cart second drawer handle	55
Anesthesia chair	48
Right monitor screen button	46
Electrocardiogram leads	42
Intravenous stopcock	42
Medication vial	49
Intravenous pole	38
Anesthesia breathing bag	37
Anesthesia circuit ventilator control	34
Oxygen dial	32
Anesthesia cart first drawer handle	28
Right monitor screen knob	27
Intravenous bag	25
Operating table	24
Volatile anesthesia agent dial	24
Breathing circuit pressure valve	23
Clipboard	23
Intravenous rate control	20

Quantification of bacterial contamination of frequently touched objects (study phase 2)

The 20 most frequently touched objects (Table 1) were targeted for pathogen culture in a subsequent analysis of a second set of 5 surgical cases. This phase was conducted separately to avoid potential influence of the culture technician on HH and/or environmental contact patterns of the anesthesia providers.

Microbiologic techniques

The frequently touched environmental surfaces that were identified in the first study phase (Table 1) were aggressively decontaminated before the start of a second set of 5 similar surgical cases in which video observation was not used. Surfaces were decontaminated with a quaternary ammonium disinfectant (Dimension III; Butchers, Sturtevant, Wis) according to the manufacturer's suggested protocol. Using previously validated culture methodology for surveillance of anesthesia environmental reservoirs,[10] serial bacterial cultures of these objects were then obtained using sterile polyester fiber-tipped applicator swabs moistened with sterile transport medium (BactiSwab; Remel, Lenexa, Kan) rolled repeatedly over the surface of the object. The samples were immediately inoculated on sheep blood agar plates using a zigzag pattern and swab rotation to detect both gram-positive and gram-negative bacteria. Cultures were obtained at baseline before surgery, at 30-minute intervals during the operation, and at case end after the patient had left the room. Blood agar plates were incubated at 37°C for 48 hours. The presence or absence of microorganisms was determined and each culture was quantified in colony forming units per surface area sampled. Bacterial species identified were consistent with that previously described,[13] including major bacterial pathogens such as *Staphylococcus aureus*, *Enterococcus* spp, and a plethora of gram-negative organisms. However, the