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Use of an anaesthesia workstation barrier device to decrease contamination in a simulated operating room

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Abstract

Background. Strategies to achieve reductions in perioperative infections have focused on hand hygiene among anaesthetists but have been of limited efficacy. We performed a study in a simulated operating room to determine whether a barrier covering the anaesthesia workstation during induction and intubation might reduce the risk of contamination of the area and possibly, by extension, the patient.

Methods. Forty-two attending and resident anaesthetists unaware of the study design were enrolled in individual simulation sessions in which they were asked to induce and intubate a human simulator that had been prepared with fluorescent marker in its oropharynx as a marker of potentially pathogenic bacteria. Twenty-one participants were assigned to a control group, whereas the other 21 performed the simulation with a barrier device covering the anaesthesia workstation. After the simulation, an investigator examined 14 target sites with an ultraviolet light to assess spread of the fluorescent marker of contamination to those sites.

Results. The difference in rates of contamination between the control group and the barrier group was highly significant, with 44.8% (2.5%) of sites contaminated in the control group *vs* 19.4% (2.6%) of sites in the barrier group ($P<0.001$). Several key clinical sites showed significant differences in addition to this overall decrement.

Conclusions. The results of this study suggest that application of a barrier device to the anaesthesia workstation during induction and intubation might reduce contamination of the intraoperative environment.

Key words: anaesthesiology; high fidelity simulation training; infection control

Regulatory agencies have identified the reduction of health-care-associated infections as a major priority.[1] With frequent, close patient contact, anaesthetists are key players in infection control.

Appropriate and timely antibiotic administration,[2] maintenance of normothermia,[3] and adequate hand hygiene[4–6] are all areas where anaesthetists may contribute to the reduction in health-care-associated infections. A previous study attempted to tackle the reduction of cross-contamination by using a double-glove method.[7] However, anaesthesia providers (like other health-care providers) have been shown to have poor rates of adherence to hand hygiene.[8–11] Even when proper hand hygiene is adopted, after airway instrumentation bacterial contamination (with oral flora) can still be found on the anaesthesia workstation, i.v. stopcocks, and other equipment.[5 12–14] Given that the workstation is not commonly cleaned during a procedure, the reservoir of bacteria left in the anaesthesia provider's work area after airway instrumentation might render the use of gloves and

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Editor's key points

- All operating theatre personnel should be involved in strategies to reduce the incidence of surgical site infections.
- Hand hygiene should be accompanied by efforts to prevent contamination of equipment.
- Anaesthetic machines are always present, easily contaminated, and difficult to decontaminate.
- The efficacy of a physical workstation barrier in preventing bacterial spread during anaesthetic induction was studied.

hand hygiene ineffective. Although this places individual patients at risk, perhaps even more worrisome is the fact that bacterial transmission between surgical patients via an incompletely decontaminated operating room (OR) occurs frequently and is linked to an increased rate of 30 day postoperative infections.[12 15] Recent research in transmission dynamics of bacteria within ORs has shown that a contaminated environment, rather than provider hands, is the most likely source of infection.[12 16] The morbidity associated with such contamination may be substantial; patients whose i.v. tubing is colonized with bacteria in the OR have an increased risk of mortality[13 16] and an increased rate of 30 day postoperative infections.[16] One study demonstrated an 8% risk of infection associated with exposure to nosocomial Gram-negative bacteria.[12] These findings suggest that dirty provider hands, although the proximal cause of contamination, are less likely to serve as a reservoir for injurious bacterial transmission events than patient or environmental surfaces, raising the importance of interventions other than optimization of hand hygiene.

Reducing early contamination of the anaesthesia environment is a complementary step that relies less on individual practitioner compliance than does hand hygiene. Although traditional barrier techniques (e.g. gloves) are well accepted, a physical barrier covering the anaesthesia workspace might reduce health-care-associated infection rates by decreasing the initial contamination after airway management. This barrier could be present for this 'dirty' portion of the anaesthetic and would then be removed and discarded. Additionally, a barrier has the advantage of serving as a passive intervention, as opposed to hand hygiene, which necessitates active participation from clinicians to be effective. We therefore used a simulated OR and a previously described model of the intraoperative spread of infection[7 17] to determine whether implementation of this anaesthesia workstation barrier method would be effective in reducing contamination of the intraoperative environment.

Methods

After being granted an exemption from written consent by the institutional review board, 42 participants, consisting of anaesthesia residents (23) and attending anaesthetists (19), were voluntarily enrolled in the study, which was carried out in the Mount Sinai Department of Anesthesiology's Simulation Center. The study was designed as a prospective, randomized controlled trial, but was not blinded given the nature of the barrier intervention. Our primary hypothesis was that the barrier device would reduce the overall rate of contamination between groups, with the secondary hypothesis that the device would primarily reduce rates of contamination of sites covered by the barrier device. The primary outcome measure was the total proportion of sites contaminated in each group. The secondary outcome measure was the rate of contamination of each individual site.

After randomization to either the control or the barrier group, participants were presented with a simulated patient requiring laparoscopic appendectomy, in which the presence or absence of the barrier was the only variable. Participants were provided with the drugs and equipment necessary for a typical induction in the sponsoring institution, which were prepared in a standardized fashion. The simulation administrator instructed all participants to wear gloves and perform all standard tasks up to the point where the patient was prepped and draped for surgery. Antibacterial hand gel was not used in this simulation.

The barrier device was fashioned from waterproof, transparent plastic, which was affixed to the anaesthesia workstation with tape and covered the surface of the anaesthesia workstation, manual ventilation bag, adjustable pressure limiting valve, ventilator switch, and ventilator monitor as seen in Fig. 1. Three pieces of plastic were used, one covering the workstation, one covering the manual ventilation bag, and one covering the ventilator monitor. In our experience, setting up the barrier took <3 min. In this study, the computerized record-keeping system was not used for logistical reasons given the set-up of our human simulator laboratory, and so this site was not targeted with a barrier cover.

A stepwise simulation sequence (Table 1) was followed for both groups, with the only difference being that in the barrier group the participants were instructed to remove the barrier as part of the surgical timeout (i.e. before surgical incision).

Fourteen target sites were used for our study, adapted from Birnbach and colleagues' model of simulation-based infection control (Table 2).[7 17] Before the entry of the subject into the laboratory, Glo-Germ fluorescent marker (Glo-Germ Company, Moab, UT, USA) 1 ml was placed in the oropharynx of the mannequin (HPS; CAE Healthcare Canada Inc., Saint-Laurent, QC, Canada).

After completion of the simulation, the barrier was removed and target sites were examined for simulated contamination using a black light and coded as either (0) not contaminated or (1) contaminated based on the presence or absence of fluorescent marker. The researcher examining sites and recording data was blinded to whether or not the barrier was used for that subject's simulation. Between simulations, the room was cleaned with soap and water wipes and again examined with a black light for residual fluorescent marker which, if identified, was removed by spot cleaning. Contaminated materials that could not be cleaned completely were discarded and replaced.

Statistical analysis

For each individual target site, the rates of contamination between the barrier device group and the control group were compared using the χ^2 test or Fisher's exact test, as appropriate. Site comparison was performed without adjustment made for multiple comparisons, and thereafter, with adjustment via step-down Bonferroni and Hochberg analysis. For the overall performance assessment, a subject-specific contamination rate was calculated first (i.e. number of contaminated sites over the 14 targeted sites for each subject). Then a two-way ANOVA was used to determine whether the overall contamination rates differed between control and barrier groups and between residents