PaTricia A. Maslyk, CRNA, MS
Daniel A. Nafziger, MD
Susan M. Burns, BS, CIC
Philip R. Bowers, CRNA, MS
Detroit, Michigan

Microbial growth on the anesthesia machine

The purpose of this study was to determine the amount of microbial growth that develops on the anesthesia machine after a full day's use in the operating room. This descriptive bacteriology study is relevant to anesthesia practice because of the proximity of the oropharynx and multiple body fluids to anesthesia equipment and the potential for cross-contamination to patients and staff. The Wilcoxon signed rank test was used to evaluate the change in colony-forming units (CFUs) before and after use of equipment. The resulting P *value of 0.12 indicated that the observed CFU increase was not statistically significant at the .05 level.*

The study identified many organisms that survive on the anesthesia machine tabletop, namely, coagulase-negative Staphylococcus, Bacillus, *alpha* Streptococcus, Acinetobacter, Staphylococcus aureus, *and gram-negative rods. Several were expected to be found; however, alpha* Streptococcus, Acinetobacter, S *aureus, and gram-negative rods are pathogenic organisms causing respiratory infections and bacteremia, especially in patients with compromised conditions. Terminal cleaning methods may have changed during the course of the study, thereby contributing to the volume of microbes present before use and distorting the change in the number of CFUs before and after use.*

Key words: Anesthesia machines, bacteriology, colony-forming units (CFUs), infection control, microbes.

Infection control is an important factor in all areas of clinical practice, including patient units, diagnostic laboratories, and surgical suites. The spread of the human immunodeficiency virus (HIV) and the growing epidemic of hepatitis and the recurring tuberculosis bacterium, not to mention the newer strains of drug-resistant bacteria, pose a constant threat to patients and clinical practitioners alike.

Infectious processes threaten not only the health of the patient but also that of the anesthesia provider and any patients undergoing a later procedure in that operating room (OR) suite. With the advent of budget cuts, tight restrictions placed on practitioners by time studies, OR turnover, and any inadvertent delays, anesthesia providers are pressed to provide care as expeditiously as professionally possible. The very nature of anesthesia requires close monitoring of all vital signs, fluid intake and output, level of consciousness, and safety. To carry out these tasks, many skills must be initiated, including endotracheal intubation, intravenous and arterial catheter placement, gastric decompression, indwelling urinary catheter drainage measurement, and administration of blood products. Each of these requires contact with body fluids and attention to infection control policies and procedures.

In 1996, a symposium on infection control in anesthesia was held in which the major pathogens were highlighted, namely, HIV and hepatitis B virus, as well as the reemergence of tuberculosis; the dangers they presented to both the anesthetist and the patient also were highlighted. However, in an editorial published thereafter, Horan and Knoblanche[1] wrote: "No details of measures taken to exclude routes of inoculation other than via the anesthetic circuit have been published." It is the need for further study in this field that provided the impetus for the present research.

Methicillin-resistant *Staphylococcus aureus* was shown to be viable and pathogenic for animals and humans after being allowed to dry on environmental surfaces for several days to more than a week.[2] It is for this reason that the hypothesis states that there will be an increase of pathogens by the end of the workday.

The area of clinical practice that seems to have had the most investigation and research regarding infection control in the 1990s is clinical dentistry. Perhaps this was due in part to the infamous report about the dentist infecting his patients with HIV in the early 1990s. In 1993, researchers reported their findings about the transmission and antisepsis related to HIV in clinical dentistry.[3] They pointed out that "HIV on surfaces contaminated by body fluids appears likely to survive at room temperature for up to 7 to 14 days and it survives in lymphilised blood. HIV may still be infective on articles that have been in contact for at least 90 minutes."

Researchers in dentistry found that the surfaces most often contacted manually had the highest level of contamination.[4] Certainly the anesthesia machine tabletop and flowmeter dials are in constant hand contact with the nurse anesthetist.

Finally, one study of infection control precautions in anesthesia found that 88% of anesthesiologists adhered to Centers for Disease Control and Pre-

vention guidelines to prevent transmission when caring for patients seropositive for HIV and patients with hepatitis B, yet only 25% adhered to those guidelines with low risk patients.[5]

These guidelines and clinical practices served as the foundation for this study to answer the question: "What is the extent of microbial growth found on the anesthesia machine tabletop at the end of a typical workday in the operating room?"

Materials and methods

Machines were selected randomly by drawing the OR numbers on random days of the week. No surgical specialty was excluded, nor was any type of anesthesia provider. A check-off list is used to designate when machines were serviced by the anesthesia technicians the day before. The machine was excluded from random sampling on a given day if it had been used for emergency cases on the late afternoon or night shift after cleaning.

Machine tabletops were swabbed with sterile, moistened (normal saline) swabs using 4 passes from edge to edge for the length and 4 passes (perpendicular to the length) from edge to edge for the width of the tabletop. The culture swabs were placed in sterile normal saline test tubes and transported to the microbiology laboratory for transfer onto chocolate, blood, and MacConkey agar culture plates using a sterile 100-µL pipette and sterile loop dispersion in 3 directions, each 90 degrees rotated from the previous streak direction. The culture plates were incubated for 24 hours at standard microbiology temperatures of 35°C.

Quantification of the number of colony-forming units (CFUs) was conducted by gross examination by the head of the microbiology laboratory in conjunction with the primary investigator.

Identification of specific microbes was done by gross examination and by use of gram-positive and gram-negative staining and a standard light microscope by the head of the microbiology laboratory or by the Vitek system (bioMérieux, Marcy-Étoile, France) of biochemical identification.

There were certain assumptions in the design of the study. The first was that the machines were being cleaned according to institutional infection control guidelines at the end of every workday. This was observed during a pilot study done 6 months before the commencement of the actual study. The second assumption was that the anesthesia machines were the main work surface for anesthesia care provided by the clinician. The machine tabletop was chosen because it would be used whether the anesthetic provided was general, regional, or monitored anesthesia care. Other sites such as the circuit, vaporizers, or flowmeters were not chosen for culture as they might not be used in all types of cases.

No human or animal subjects were used in the study, and the protocol was presented to and passed by the institutional review boards of the participating hospital and the university.

Results

The study identified many organisms that survived on the anesthesia machine tabletop, namely, coagulase-negative *Staphylococcus, Bacillus*, alpha *Streptococcus, Acinetobacter, S aureus,* and gram-negative rods. All require manual or fluid transmission, and several were expected to be found due to their normal environmental presence, specifically, coagulase-negative *Staphylococcus* and *Bacillus* (Table 1).

However, alpha *Streptococcus, Acinetobacter, S aureus,* and gram-negative rods are pathogenic organisms usually inhabiting the oropharynx of the host and causing upper respiratory infections and bacteremia.

Acinetobacter, which tends to evolve seasonally, was isolated from an OR that housed an intensive care unit (ICU) patient who, as revealed by retrospective investigation, had a positive culture for *Acinetobacter* postoperatively. A series of infections by *Acinetobacter* was identified in ICU patients by the microbiology department at the same time.

Previous studies revealed that approximately 13 ± 21 CFUs were found.[6] Assuming that the measurements that are taken on the same day in the same OR have a correlation of 0.9, with 38 samples, we would have 80% power (alpha = .05; 2-sided test) to detect a change in CFUs of 50% (an increase of 13 to 19.5 in the number of CFUs). The biostatistician serving as a consultant for the project stated that changes of this magnitude were clinically significant (M. Jankowski, Study proposal. Biostatistics and Research Epidemiology, Henry Ford Hospital Biostatistics and Research Epidemiology, Detroit, Mich, 1998).

The Wilcoxon signed rank test was used to evaluate the changes in CFUs before and after use of the equipment. The test examines not only the direction but also the magnitude of change in pretest-posttest measures. The resulting *P* value of .12 indicated that the observed CFU increase was not statistically significant at the .05 level.

Discussion

Although the resulting *P* value did not demonstrate a significant difference in CFUs before and after use, the results indicate several important findings (Table 2). Some machines showed no change in CFUs before

Table 1. Cultured microorganisms

Microorganism cultured
Pathogenic
Alpha *Streptococcus*
Acinetobacter
Staphylococcus aureus
Gram-negative rods
Nonpathogenic
Coagulase-negative *Staphylococcus*
Bacillus

Table 2. Cultured volume of colony-forming units (CFUs)

Variable	Mean	SD	Median	Minimum	Maximum
Preuse CFUs	23.9	38	10	0	145
Postuse CFUs	52.4	99	20	0	380
CFU change	28.5	81	5	–90	235

and after use, as was the case in 13 of 38 samples taken. These machines were clean to start and clean at the end of the day. However, other changes spanned a wide range, eg, –90 to 235 CFUs, indicating that some machines were more contaminated before use than after, while others were grossly contaminated after the average 8 hours of use.

This wide range of results could be attributed to several causes. First, the discrepancy may have been caused by experimenter technical error in obtaining the culture samples or preparation of the culture plates in an inconsistent manner. The samples were obtained by only the chief investigator who followed the same protocol on each. However, contamination of samples or plates may have occurred in this process. Second, the plates were prepared using standard sterile technique established by the microbiology department, without use of a laminar airflow hood. Third, there may have been inconsistent use or nonuse of the machine tabletop during the course of the day by the anesthesia provider. Fourth, the time lag between obtaining the samples in hourly batches as use of rooms ended for the day and preparation of the culture plates may have been inconsistent. Finally, it is possible that terminal cleaning techniques by a reduced technical support staff during the study may have contributed to the volume of preuse microbes, thereby distorting the change in the number of CFUs before and after use.

Conclusion

Although the statistical results did not demonstrate an increase of 50% growth or more in CFUs during the day, the samples revealed many organisms that survived on the anesthesia machines before and after use. Several of the microbes were pathogenic and posed a threat to both staff and succeeding patients scheduled for a procedure in that OR suite. One organism, *Acinetobacter,* was a virulent pathogen, causing bacteremia in the ICU, and was isolated not only in the OR in which the patient underwent surgery but also in the adjoining OR. This demonstrates how easily pathogens can be transferred between and around different departments, especially on inanimate objects such as an anesthesia machine tabletop. Ioset and Rossmann[7] cited findings in dentistry of pathogens being transferred from the patient's mouth to the fingers of dental hygiene students and then to chair switches and sink handles. The same report cites another study in which oral pathogens could be transferred from one patient to radiographic equipment and then to the next patient, and that many pathogens such as influenza, herpes simplex I virus, Rhinovirus, Epstein-Barr virus, and *Neisseria gonorrhoeae,* to name just a few, require only inoculation in adequate numbers onto mucosal tissue for infection to occur. More important, aerobic bacteria survived at least 48 hours. Since there is similar exposure to the oropharynx between dentistry and anesthesia, there seem to be the same risks to clinicians and patients in the OR suite.

Suggestions for further study include sampling before use only after the investigator has disinfected the machine, rather than permitting the institution's staff and protocols to be implemented, which poses a threat to internal validity when the desired information is the number of CFUs "added" to the anesthesia machine tabletop during a regular workday.

Viruses were not cultured because of the prohibitive cost of such cultures, which varies from $60 to $100 per plate. Funding from an outside source may make investigation of this threat possible.

Infection control guidelines have been established by the Association for Professionals in Infection Control and Epidemiology, Inc, and adopted by the Centers for Disease Control and Prevention, as well as by the American Society of Anesthesiologists.[8] One author wrote that "repeated attempts to demonstrate survival of pathogens in anaesthetic apparatus have failed; no outcome studies comparing normal commonsense

housekeeping and handwashing with the costly routines now being imposed have been published."[9]

A comparison of cleaning and disinfection protocols, types of disinfectant, and different time intervals for cleaning may demonstrate the need for change in an institution's policies and procedures regarding anesthesia machines.

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AUTHORS

Patricia A. Maslyk, CRNA, MS, is a nurse anesthetist at Genesys Regional Medial Center, Grand Blanc, Mich.

Daniel A. Nafziger, MD, is medical director, Epidemiology, at Henry Ford Hospital, Detroit, Mich.

Susan M. Burns, BS, CIC, is infection control specialist, at Henry Ford Hospital.

Philip R. Bowers, CRNA, MS, is a staff nurse anesthetist at Oakwood Health System Annapolis Center, Wayne Mich.

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