Incidence of visible and occult blood on laryngoscope blades and handles

Capt RITA A. PHILLIPS, CRNA, MSN, USAF, NC
W. PATRICK MONAGHAN, CLS, SBB, PhD
Fort Worth, Texas
Winner of 1996 Student Writing Contest

Anesthesia providers must take appropriate precautions to reduce the potential for transmission of infectious agents to the patients under their care. The devastating spread of human immunodeficiency virus (HIV) and hepatitis B virus (HBV) over the past decade has resulted in the development of specific guidelines for the cleaning, disinfection, sterilization, and handling of medical equipment and instruments. Contamination of laryngoscope blades and handles with visible and occult blood frequently occurs during routine airway management. Several studies suggest procedures for cleaning, disinfection, sterilization, or handling of laryngoscope blades and handles are ineffective, or there may by poor compliance with the established protocols.

The purpose of this study was to determine the incidence of visible and occult blood on laryngoscope blades and handles that were identified as ready for patient use. Sixty-five laryngoscope blades and handles identified as ready for patient use were observed for visible blood and tested for occult blood. A modified version of the three-stage phenolphthalein blood indicator test was employed to determine the presence of occult blood. None of the blades or handles observed had visible blood. Of the 65 blades tested for occult blood, 13 (20%) tested positive. Of the 65 handles tested for occult blood, 26 (40%) tested positive. More afternoon blades and handles tested positive for occult blood than morning blades and handles ($P < 0.01$).

The extent to which contaminated anesthesia equipment plays in nosocomial infection is difficult to determine. The presence of blood is an indicator of potential cross-infection, since biological fluids, such as blood and saliva, are known to transmit infectious diseases. This study confirms that more rigorous decontamination protocols must be instituted to ensure complete removal of blood prior to sterilization, since laryngoscope blades and handles have irregular surfaces with repositories for infectious material.

Key words: Anesthesia equipment, equipment sterilization, laryngoscope, occult blood, universal precautions.

Introduction

There are few documented cases of anesthesia related transmission of nosocomial infection. However, actual documented cross-infection by anesthesia equipment may be rare due to the difficulty in establishing a causal relationship between anesthetic practice, equipment contamination, and

postoperative infection.[1,2] This may be the result of long incubation periods and subclinical infections associated with certain bloodborne pathogens, such as human immunodeficiency virus (HIV), hepatitis B virus (HBV), and hepatitis C virus (HCV). Once contracted, these viruses are extremely difficult and costly to treat and are oftentimes fatal.[3] Therefore, the effectiveness of anesthesia equipment cleaning, disinfection, sterilization, and handling needs to be verified.

A significant factor in preventing nosocomial infections was the development of disinfection and sterilization procedures for medical instruments and equipment. Spaulding devised a classification scheme that has been used as the framework for identifying appropriate levels of disinfection or sterilization for all medical instruments, equipment, and surfaces in patient treatment areas. The categories were based on the degree of risk of infection associated with their clinical use.[4,5] This classification scheme is so logical that the Centers for Disease Control and Prevention (CDC) also uses this system in its guidelines.[6,7] The categories are as follows:

skin or enter sterile areas of the body, such as spinal needles, surgical instruments, or implants. These items must be sterile prior to patient use.

2. *Semicritical items* are devices that come in contact with mucous membranes, such as laryngoscopes, breathing circuits, tracheal tubes, fiberoptic endoscopes, and bronchoscopes. These items require a high level of disinfection or sterilization.

3. *Noncritical items* are devices that may have contact with the patient's intact skin and seldom, if ever, become contaminated with patient material such as blood. Examples of such items are blood pressure cuffs, pulse oximeter probes, electrocardiogram electrodes, and stethoscopes. These items can be washed or scrubbed with a detergent and warm water for an adequate level of safety; however, in some instances, an intermediate- to low-level chemical germicide may be used for added assurance of safety.

The purpose of this study was to determine the incidence of visible and occult blood on laryngoscope blades and handles that were identified as ready for patient use. The presence of blood is an excellent indicator of potential cross-infection since blood is known to transmit many bloodborne infectious diseases.

Materials and methods

Following institutional approval, data for this descriptive study was collected at a medical facility with five to seven operating rooms in daily use. According to the facility protocol, at the end of every general anesthesia case, an anesthesia technician dismantles the blade from the handle and proceeds with the following protocol:

1. The blades are soaked in Haemosol®, mechanically washed, then followed with a sterilization cycle in the Steris™ sterilizer. The sterile blades are then kept in a clean area until needed.

2. The handles are washed with a hospital approved agent after every use, then returned to the top of the anesthesia cart, although in reality they are only cleaned if grossly contaminated.

The usual practice for cleaning and disinfecting equipment in these operating rooms was continued throughout the study.

The Steris sterilizer is a U.S. Food and Drug Administration and Environmental Protection Agency approved sterilizer that utilizes paracetic acid which is bactericidal, fungicidal, and sporacidal at 0.3% concentration. Unlike other automated processors, the Steris machine has no cleaning cycle. To ensure the system is operational, a diagnostic cycle is performed at the beginning of each day. In addition, a biologic spore strip is used to challenge the sterilizer, usually at the beginning of each day. One major advantage of this system over the glutaraldehyde technique is that personnel are not directly exposed to the chemical agent, although the costs per cycle are higher since the peracetic acid is not reused.[8,9]

The laryngoscopes studied were identified as "patient ready" prior to inspection. Daily sampling occurred prior to the beginning of the day's cases and at the end of the day's cases until 65 laryngoscope blades and handles were inspected. The surface of each laryngoscope blade and handle was first carefully inspected for the presence of visible blood. Next, the blade and handle were wiped with separate 70% isopropyl alcohol pads. Each alcohol wipe was placed in a plastic zipper storage bag appropriately labeled with either blade or handle, morning or afternoon, and room number. To test for occult blood, the modified three-stage phenolphthalein blood indicator test was performed at the end of the day. The samples were placed on a white background to better distinguish between the positive and negative results, and a second reading was obtained for all results.

A preliminary study was performed to determine the sensitivity of the three-stage phenolphthalein blood indicator test The literature is varied on this subject, ranging from 1:1,000 to 1:10,000,000 concentration.[10] A 10-tube serial dilution was conducted starting with 1:10 (one drop of blood in nine drops of normal saline) and ending with 1:10,000,000,000. The negative control contained 10 drops of normal saline. A standardized

plastic disposable pipette was used to place one drop (0.05 milliliters) from each test tube on an alcohol wipe. The modified three-stage phenolphthalein blood indicator test was utilized:

1. The alcohol pad was observed for discoloration.
2. One drop of phenolphthalein was added to the center of the alcohol pad. If a pink color was present at this time, a contaminant was present which made the test invalid (false-positives were eliminated). If no reaction occurred at this time (normal).
3. One drop of hydrogen peroxide was added. Blood was indicated if a pink color was observed within 60 seconds.

The test was repeated as above with the following changes:

1. The alcohol wipes were placed in plastic disposable zipper-lock bags after being contaminated.
2. The modified three-stage phenolphthalein test was performed 12 hours later to simulate how actual testing would be performed.

The manufacturer's instructions are to wipe the suspected blood contaminated surface with filter paper, followed by the addition of one drop of 70% isopropyl alcohol. The modification of the three-stage phenolphthalein test combines these first two steps into one. The same 10-tube serial dilution was repeated a third time with filter paper and alcohol instead of alcohol wipes to ensure that the modification did not change the validity of the phenolphthalein blood indicator test.

A known bloodstain control card, supplied by the phenolphthalein test kit manufacturer, was used to verify the solutions' integrity. In addition, the reagents were tested on plain, uncontaminated alcohol wipes and filter paper to rule out false-positive reactions.

The phenolphthalein test works on the principle of an oxidation-reduction reaction. The phenolphthalein reagent is oxidized in the presence of the hemoglobin group which possesses a catalytic peroxidase-like activity. As a result of the heme group, the hydrogen peroxide is broken down, and the oxygen is transferred to the phenolphthalein reagent, causing it to be oxidized. This results in the pink color change (Phenolphthalein Test Kit, Cluefinders, Inc., Tampa, Florida).

In all three preliminary studies, the sensitivity of the phenolphthalein blood indicator test at 60 seconds was 1:10,000 parts blood to normal saline. There were no differences between the three tests. The known bloodstain control card tested positive immediately, and at no time did the negative controls test positive.

All results were recorded as yes or no on a data collection tool. The collected data were analyzed and percentages were computed based on the relative rate of occurrence. Finally, the standard error of a proportion of rates of occurrence were calculated to determine the significance ($P<0.01$) using the following formula:[11]

$$z = \frac{p - \pi}{\pi (1-\pi)/n}$$

where p = Proportion observed in the sample
π = Hypothesized value of the population proportion
n = Number of people in the sample

Results

None of the 65 blades or handles observed in this study had visible blood. The alcohol pad was visibly discolored after wiping one (2%) blade and four (6%) handles. Of the 65 blades tested for occult blood, 13 (20%) tested positive at 60 seconds. Of the 65 handles tested for occult blood, 26 (40%) tested positive at 60 seconds (Tables I and II and Figure 1). Of the total 65 blades and handles tested, there were 35 blades and handles tested in the morning and 30 blades and handles tested in the afternoon. There were statistically significantly more afternoon blades (n = 9) and handles (n = 14) that tested positive for occult blood than morning blades (n = 4) and handles (n = 12) (Figure 2). Standard error of a proportion of rates of occurrence were calculated to test the significance of the differences of the total rates of occurrences of 20% and 40% and to test the significance of the differ-

Table I
Incidence of occult blood on laryngoscope blades and handles (n = 65)

	Total		*Occult blood*	
	Blades	*Handles*	*Blades*	*Handles*
Morning	35	35	4	12
Afternoon	30	30	9	14
Total	65	65	13	26

Table II
Occurrence of occult blood on laryngoscope blades and handles (n = 65)

	Blades	*Handles*
Morning	11%	34%
Afternoon	30%	47%
Total	20%	40%

Figure 1

Occurrence of blood on "ready to use" laryngoscope blades and handles (n = 65)

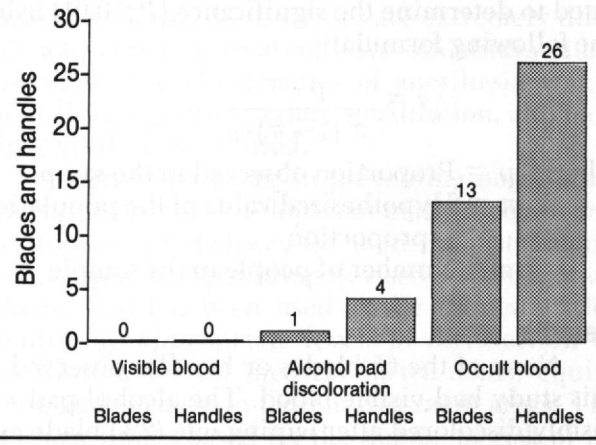
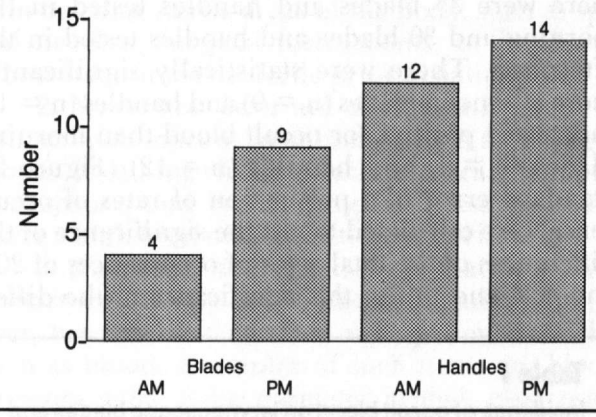


Figure 2

Occurrence of blood on laryngoscope blades and handles in the morning (AM) and afternoon (PM) (n = 65)



ences of the morning and afternoon occurrences. All comparisons were significant at $P<0.01$.

Discussion

Occult blood was present on 20% (n = 13) of laryngoscope blades and 40% (n = 26) of laryngoscope handles that were identified as ready for patient use. These findings are consistent with a similar study done in 1994.[12] Using a guiac-based test for occult blood with a reported sensitivity of 1:10,000, these researchers found occult blood on 10.5% of laryngoscope blades and 50% of laryngoscope handles tested. Their conclusions were that the use of more rigorous decontamination protocols, disposable equipment, or disposable blade and handle covers are necessary if anesthesia providers are to use clean equipment free of infectious material. The guiac-based and modified three-stage phenolphthalein blood indicator tests both have a reported sensitivity of 1:10,000, making either test appropriate to test for occult blood. However, the modified three-stage phenolphthalein blood indicator test seems easier to use on rough surfaces and perhaps has a more clearly positive result.

In the current study, none of the 65 blades or handles tested revealed visible blood. In addition, only one (2%) blade and four (6%) handles had discoloration on the alcohol pad after wiping and before testing the 65 blades and handles for occult blood. This finding demonstrates that equipment may appear clean to the anesthesia provider but still be contaminated with blood or other potentially infectious materials, such as bacteria. Visual inspection is not a reliable means of detecting blood contamination. The modified three-stage phenolphthalein blood indicator test could be used periodically to monitor the incidence of occult blood on laryngoscope blades and handles, as well as other anesthesia equipment.

This study did not determine whether the presence of blood poses an actual risk of infection to the patient or not. However, the presence of blood is an indicator of potential cross-infection since blood is known to transmit bloodborne infectious disease. HBV and HIV antigen testing shows HBV to be much more viable than HIV. The viability of the hepatitis virus has been demonstrated for up to 2 weeks on metal surfaces, and the antigenic stability can exist for up to 7 years.[13] Using HIV infectious doses 100,000 times greater than that typically found in the blood or serum of patients with HIV infection, studies have shown HIV detectable by tissue-culture techniques 1 to 3 days after drying. The CDC has also shown the rapid reduction in HIV concentration (several hours) with drying.[6] Based on these findings, HBV and HIV might be spread from patient to patient or patient to provider unless proper cleaning and disinfection of laryngoscope blades and handles is performed between each patient use.

The degree to which contaminated anesthesia equipment is a factor in the overall nosocomial infection rate is difficult to determine. The intact oral mucosa may offer somewhat of a barrier against infection. However, it has been demonstrated that the oral mucosa is oftentimes traumatized during routine laryngoscopy and oral intubation, and mucosal breeches may not be obvious to the eye. Contamination of laryngoscopes with visible and occult blood frequently occurs during routine airway management.[14,15] Anesthesia providers routinely care for patients with functionally impaired immune systems, such as patients with

diabetes mellitus, alcoholism, uremia, burns, pregnancy, prematurity, rheumatic diseases, and cancer. Less frequently, they care for transplant recipients and patients with acquired immune deficiency syndrome (AIDS). Care for these patients must be more meticulous.[16] The anesthetic state itself decreases the body's response to surgical trauma by blunting pain reflexes, providing cardiovascular stability, and decreasing the release of stress hormones.[17]

The patient with an impaired immune system and altered mucous membranes is more vulnerable to postoperative nosocomial infection. Laryngoscope blades, therefore, should receive a thorough cleaning and high level disinfection or sterilization after each patient use. The laryngoscope handle should possibly be recategorized into Spaulding's semicritical category and, therefore, it should also receive a high level of disinfection or sterilization after each patient use to prevent transmission of infectious disease from patient to patient or patient to provider.

This study found a significant increased incidence of occult blood on the blades and handles in the afternoon when compared to the morning. This finding suggests that there is an increased incidence of contamination of blades and handles in the afternoon when compared with the morning. This may be due to improper handling of anesthesia equipment throughout the day. For instance, dirty laryngoscope handles are frequently returned to the top of the cart with all the clean syringes, tubes, airways, and other equipment. An unused laryngoscope blade is then placed on the used handle. The laryngoscope blade routinely comes in contact with the laryngoscope handle in the folded and waiting to be used position. Therefore, the used laryngoscope handle can serve as a fomite for infectious agents.

In addition, the anesthesia provider oftentimes performs many tasks with the same pair of disposable gloves. For example, the same pair of disposable gloves used to intubate the patient are often also worn to turn on the anesthetic agents, adjust monitoring equipment, give additional intravenous medications, tape the patients eyes closed, and perform many other tasks that must be done expediently at the start of a general anesthetic. The contaminated gloves could also serve as fomites for infectious agents and contaminate other anesthesia equipment. Hall's study in 1994 found widespread contamination of anesthesia surfaces in operating rooms with occult blood.[13] Some suggest that the following "clean" technique be employed during an induction:

1. The provider puts on two pairs of gloves.
2. Induction is carried out in the usual fashion.
3. As soon as the endotracheal tube is in place, the blade is held in the gloved hand and the outer glove is pealed off the hand and inverted over the dirty laryngoscope blade. The other outer glove is also removed leaving a clean pair of gloves to perform the other necessary tasks.

This is just one way in which anesthesia providers can improve infection control procedures in the operating rooms.[18]

Another possible reason occult blood may be present on laryngoscope blades and handles identified as ready for patient use is equipment failure. In this study, the technician soaked blades in Haemosol, scrubbed the blades manually, and then cycled the blades in the Steris sterilizer. Since the Haemosol contains an enzyme, but does not contain a detergent, perhaps the blood or debris was not being completely removed prior to sterilization. Kneedler and Darling looked at the effectiveness of soaking instruments in an enzymatic detergent solution during the initial cleaning process as a means of loosening and removing the bioburden before sterilization. Their conclusions were that detergent-enzymes can eliminate the need for manual cleaning, thus reducing the exposure of personnel to pathogens during the cleaning process. In addition, soaking in enzymatic detergent solutions can reduce the number of bacteria in many cases, but these products are not substitutes for sterilization.[19]

Poor compliance with established cleaning and disinfecting protocols is another reason occult blood might be present on laryngoscope blades and handles. Tait and Tuttle's survey of 4% of practicing anesthesiologists in the United States suggests either poor compliance or unfamiliarity with established cleaning and disinfection protocols.[2] Only 69% of those surveyed disinfected their laryngoscope blades in an acceptable manner. Anesthesia providers should be instructed in basic infection control procedures during their anesthesia education. Continuous in-service education is needed, however, to improve, supplement, and update knowledge in this field after their formal education. Anesthesia providers should be made aware of studies related to infection control to increase their awareness of the disinfection and sterilization policies and procedures.

An effort must be made by manufacturers of reusable anesthesia equipment to design more durable equipment that can be more easily and effectively cleaned and sterilized. Manufacturers have designed disposable equipment such as single use laryngoscope blades and handles or disposable

plastic or latex blade and handle covers. Anesthesia providers find this equipment cumbersome and costly while being an insufficient substitution for currently used laryngoscope blades and handles.

There are several limitations to this study. First, the anesthesia staff was made aware of the proposed study, and subsequent behavioral modification could possibly have skewed the results of the study. Generalizing the results of this study beyond this medical facility is limited. Further study should be done involving several medical facilities, using a larger sample size, for a longer time period to generalize the results of this study.

Results from this study suggest the procedures for cleaning, disinfection, sterilization, and handling of laryngoscope blades and handles are not effective as evidenced by occult blood detected on laryngoscope blades and handles identified as ready for patient use. The presence of blood is an indicator of potential cross-infection, since biological fluids, such as blood and saliva, are known to transmit infectious diseases. Anesthesia providers must take every appropriate precaution to reduce the potential for transmission of infectious agents to the patients under their care.

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AUTHOR

Capt Rita A. Phillips, CRNA, MSN, USAF, NC, is currently stationed at the United States Air Force Academy, Colorado Springs, Colorado. She received her BSN from the University of Southern Mississippi, Long Beach, Mississippi, in 1990, and an MSN in Nurse Anesthesia from the Uniformed Services University of the Health Science Graduate School of Nursing, Nurse Anesthesia Program, Rockville, Maryland, in 1996.

W. Patrick Monaghan, CLS, SBB, PhD, is a professor at the Graduate School of Nursing of the Uniformed Services University of the Health Sciences, Bethesda, Maryland. He is a certified clinical laboratory scientist and blood bank specialist. His doctorate is in hematology.