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Emerging Evidence in Infection Control Effecting Change

Melissa Dawn Machan

University of North Florida

EMERGING EVIDENCE IN INFECTION CONTROL EFFECTING CHANGE

by

Melissa Dawn Machan

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Certificate of Approval

The project of Melissa Dawn Machan is approved:

Signature Deleted

John McDonough, EdD, Committee Member — Date: 8 Dec 2011

Signature Deleted

Gerard Hogan, CRNA, DNSc, ARNP, Committee Member — Date: 8 DEC 2011

Signature Deleted

W. Patrick Monaghan, CLS, SBB, PhD, Committee Chairperson — Date: Dec 08, 2011

Accepted for the School of Nursing:

Signature Deleted

Lillia Loriz, PhD, GNP, BC, Director, School of Nursing — Date: 12-8-11

Accepted for the College:

Signature Deleted

Pamela S. Chally, PhD, RN, Dean, Brooks College of Health — Date: 12-8-11

Accepted for the University:

Signature Deleted

Len Roberson, PhD, Dean of the Graduate School — Date: 12-20-2011

Dedication

I dedicate this evidence based practice project to my husband Stephen and son Jonathan. Without my husband's patience, understanding, support, and most of all love, the completion of this work would not have been possible. I would also like to recognize the members of my doctoral committee and other faculty that have worked tirelessly to make the completion of this project and manuscript possible.

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Abstract

Current procedures for cleaning anesthesia airway equipment have been reported to be ineffective. The potential for cross-contamination from some airway equipment to a patient has been documented in several studies. In order to prevent potential infections, it should be ascertained as to why all anesthesia providers are not using disposable laryngoscope blades.

The purpose of this evidence based project is to determine the perceptions of anesthesia providers regarding the use of disposable laryngoscope blades. Their frequency of use, their evaluation of ease of use, and any complications encountered when using the disposable blade before and after an in-service program designed to increase the use of disposable blades will be determined.

Once Institutional Review Board (IRB) approval and written consent were obtained, anesthesia providers were asked to complete an anonymous one page questionnaire on their knowledge and practice regarding disposable laryngoscope blades. Immediately following the completion of the questionnaire, participants were given an investigator developed article to read. Participants completed the same anonymous questionnaire 3 months following the pre-intervention questionnaire. Inventory of the disposable laryngoscope blades were collected at the start of the project, at one month, and then again at three months.

A total of 12 anesthesia providers participated in the evidence based practice project. An increased number of providers stated that they felt disposable laryngoscope blades were easy to use at the completion of the project and there was an increased use of disposable laryngoscope blades. At post-intervention, anesthesia providers described

performance (25%) as their reason for not using the disposable laryngoscope blade which was down from the start of the project (60%). A single proportion Z-Test showed that the 23% increase in use of disposable laryngoscope blades after the intervention was statistically significant ($Z=2.046$, $p=0.041$). This evidence based project has shown that despite initial apprehension, a change in practice was evident after dissemination of the best and most recent clinical evidence regarding laryngoscope blades which should translate to improved patient outcomes.

Chapter One: Introduction

Nosocomial infections affect 1.7 million people and contribute to 99,000 deaths annually (Pollack, 2010), as well as cost hospitals $6.7 billion per year in the United States (Centers for Disease Control [CDC], 2004). These costs are not only burdensome to hospitals, but also significant to the average person. The greater the payout of insurance companies, the higher the standard premium will be. In view of these facts, healthcare providers should be doing everything to ensure that nosocomial infections as well as human immunodeficiency virus (HIV) and Hepatitis B (HBV), are not spread unknowingly by contaminated equipment. Since contaminated anesthesia airway equipment has a potential to transmit pathogenic organisms, anesthesia providers must be certain that the airway equipment is fully clean.

A direct cause and effect relationship between contaminated anesthesia airway equipment and nosocomial infection is difficult to establish (Phillips & Monaghan, 1997). Blood is an excellent environment for many forms of pathogenic organisms to flourish. It is easy, therefore, to theorize that nosocomial infections could potentially result from visible and occult blood present on reusable anesthetic airway equipment. Since these infections often have major economic and health related consequences, prevention is a top priority for hospitals and insurance companies.

In today's era of deadly communicable diseases, it is easy to see the importance of proper cleaning and sterilization. As some pathogens have the ability to survive

outside of their host, health care providers must be certain that reusable anesthesia airway equipment is being both cleaned and sterilized appropriately.

Intubation of the trachea using reusable equipment creates a risk for cross-contamination because no perfect decontamination procedure exists (Galinski et al., 2003). It has been established in multiple studies that the current cleaning and sterilization techniques for reusable anesthetic airway equipment are ineffective at removing all remnants of blood (Kanefield, Munro, & Eisele, 1989; Morell, Ririe, James, Crews, & Huffstetler, 1994; Phillips & Monaghan, 1997; Hall, 1994; Perry & Monaghan, 2001; Ballin, McCluskey, Maxwell, & Spilsbury, 1999; Miller, Youkhana, Karunaratne, & Pearce, 2001; Maslyk, Nafziger, Burns, & Bowers, 2002; Williams, Dingley, Jones, & Berry, 2010; Foweraker, 1995; Wenzel & Edmond, 1997; Agerton et al., 1997). Disposable laryngoscope blades are available to prevent potential cross-contamination. These single use disposable laryngoscope blades are not widely used and have received mixed reviews from anesthesia providers (Amour et al., 2006; Jabre et al., 2007; Galinski et al., 2003; Goodwin, Wilkes, & Hall, 2006; Shahriari, Khooshideh, & Enayaty, 2007; Anderson, Gambhir, Glavin, & Kinsella, 2006; Rowley & Dingwall, 2007; Sudhir, Wilkes, Clyburn, Aguilera, & Hall, 2007; Cheung, Kovacs, Law, Brousseau, & Hill, 2007).

The Project

The purpose of this evidence based project was to determine the perceptions of anesthesia providers regarding the use of a disposable laryngoscope blade. Their frequency of use, their evaluation of ease of use, and any complications encountered

when using the disposable blade before and after an in-service training program designed to increase the use of disposable blades was ascertained.

Research Questions

1. What is the perception of anesthesia providers regarding ease of use and complications of disposable laryngoscope blades before and after the in-service program?
2. What percent of anesthesia providers use disposable laryngoscope blades before and after the in-service program?
3. How many disposable laryngoscope blades were used in the facility throughout the three months project?
4. What is the anesthesia providers' evaluation of ease of use of the disposable laryngoscope blade?
5. What are the providers' rationales for non-use of a disposable laryngoscope blade after the in-service-program?
6. What complications did anesthesia providers encounter when using a disposable laryngoscope blade?

Variables

The independent variable is the in-service training program. The dependent variables are anesthesia provider perceptions, use of disposable laryngoscope blades, and complications of use.

Definitions

Anesthesia provider. An anesthesia provider may be either a certified registered nurse anesthetist or an anesthesiologist.

Anesthesia providers' perceptions. The beliefs and attitudes of the anesthesiologist and the nurse anesthetist regarding the ease of use of disposable laryngoscope blades.

Chemical sterilants. Chemical agents that are used for the destruction of all forms of microbial life. This includes fungal and bacterial spores (Rutala, 1996).

Cleaning. The removal of all foreign debris (both organic and inorganic) from equipment (Rutala, 1996).

Complications. For the purpose of this project is refers to the inability to properly intubate the trachea.

Disinfectant. A germicide that terminates all forms of pathogenic organisms. It does not necessarily kill all forms of microbial organisms (Rutala, 1996).

Disinfection. A process in which many pathogenic organisms are eliminated with the exception of bacterial spores from equipment. This can be achieved with liquid chemicals (Rutala, 1996).

Disposable laryngoscope blade. A single use laryngoscope blade. This is used to intubate the trachea and is usually metal or plastic.

Germicide. Chemical agent that destroys microorganisms, particularly pathogenic organisms (Rutala, 1996).

High-level disinfection. A process in which all microorganisms are destroyed, with the exception of bacterial spores. Chemical examples include: 2% Glutaraldehyde-based formulas, Peracetic acid, and 6% Hydrogen Peroxide (Rutala, 1996).

In-service program. The in-service training program was designed to address practice guidelines for the use and potential complications of disposable versus reusable

laryngoscope blades. Also presented is the potential for cross-contamination issues, ease of use, and costs associated with each type of laryngoscope blade.

Intermediate-level disinfection. A process that kills most, but not all pathogenic organisms. This includes *Mycobacterium tuberculosis*, vegetative bacteria, most viruses, and fungus. It does not kill all bacterial spores. Chemical examples include sodium hypochorlite (1000 ppm of 5.2% bleach), chlorine, and 70%- 90% ethyl alcohol (Rutala, 1996).

Laryngoscope. A combination of both a laryngoscope handle and blade. This equipment is used to intubate the trachea (Dorsch & Dorsch, 1999).

Laryngoscope blade. The part of the laryngoscope that is placed in the mouth. This contains a light source at the distal end and attaches to the handle. Blades for laryngoscopy come in many sizes and shapes (Dorsch & Dorsch, 1999).

Laryngoscope handle. The handle is the portion of the laryngoscope that provides power to the blade. The blades are attached to the handle before laryngoscopy. Handles are often contaminated when using reusable laryngoscope blades. Handles also come in different sizes and shapes (Dorsch & Dorsch, 1999).

Laryngoscopy. The process of inserting a laryngoscope into the patient's mouth to visualize the vocal cords (Dorsch & Dorsch, 1999).

Low-level disinfection. This type of disinfection will kill most bacteria, some viruses, and some fungi. Chemical examples include sodium hypochorlite (100 ppm of 5.2% bleach) and quaternary ammonium germicidal detergent solution (Rutala, 1996).

Nosocomial infection. Infection acquired within a hospital (Davis, 2000).

Occult blood. Blood that can be detected by either microscopic or chemical examination (Phillips & Monaghan, 1997).

Sterilization. The complete elimination or destruction of all forms of microbial life. This is accomplished by either physical or chemical processes. These processes include steam under pressure, dry heat, low temperature sterilization processes, and liquid chemicals (Rutala, 1996).

Universal precautions. Guidelines presented by the CDC aimed at preventing transmission of communicable diseases to both health care providers and patients. Universal precautions should be applied to prevent exposure to blood, semen, vaginal secretions, breast milk, human tissue, cerebrospinal, synovial, pleural, peritoneal, pericardial, and amniotic fluid. Each of these body fluids have the potential for the transmission of disease. It is suggested to wear gloves, face shield, gown, and mask, depending on the procedure (Barash, Cullen, & Robert, 2001).

Visible blood. Blood that can be seen macroscopically on any surface without the use of microscopic or chemical examination (Phillips & Monaghan, 1997).

Chapter Two: Review of Literature

This chapter will review the literature regarding infection control practices in hospitals in general and for anesthesia airway equipment in particular. This will include a historical perspective on infection control practices with respect to reusable laryngoscope blades, the advent of disposable laryngoscope blades, and a synthesis of the available evidence with respect to provider preference and usability of reusable versus disposable blades.

Standard search procedures were used to locate published studies. Electronic databases searched were CINAHL, Medline, PubMed, and Cochrane library, using the key terms *disposable laryngoscope blade*, *single-use laryngoscope blade*, *reusable laryngoscope blades*, and *laryngoscopy*. The search was limited to the English language. Although this strategy captured a large number of studies, very few of them dealt with anesthesia provider preference and usability.

Infection Control

Favorable environmental conditions were initially established for hospital settings in the mid-twentieth century. Spaulding (1968) devised a rational approach to the disinfection and sterilization of patient care items and equipment. He believed that the nature of disinfection could be mastered more readily if instruments and items for patient care were divided into three categories according to the degree of risk of infection involved in the use of these items. The three categories of items were critical (items that enter sterile tissue or the vascular system), semicritical (items that come in contact with

nonintact skin or mucous membranes), and noncritical (items that come in contact only with intact skin). This classification scheme was so clear and logical that it has been used by the Association for Professionals in Infection Control and Epidemiology (2004), Centers for Disease Control (2008), and Occupational Safety and Health Administration (2010).

In 1987, the CDC made recommendations for the prevention of HIV transmission in health care settings by suggesting that medical devices or items that contact intact mucous membranes should be sterilized or receive high-level disinfection. They further recommended that items should be thoroughly cleaned before being exposed to the germicide. These recommendations have been adopted by many, including the Association of Operating Room Nurses (1999).

In the mid 1980s, identification of HIV in blood and body fluids motivated researchers to consider the potential risk that blood borne pathogens presented to healthcare providers. Laboratory analysis of serum or plasma specimens scheduled to be discarded by a hospital laboratory demonstrated that 1.1% were positive for HIV, 4.9% were positive for HBV, and 5.7% were positive for both (Handsfield, Cummings, & Swenson, 1987). If inanimate objects become contaminated with Hepatitis B virus and are not properly cleaned and disinfected or sterilized then these contaminated objects may contribute to disease transmission for periods of time up to one week and possibly longer (Bond, Favero, & Peterson, 1981).

Anesthesia Implications

According to the Association of Operating Room Nurses (1999), reusable anesthesia equipment, such as laryngoscope blades, that come into contact with mucous membranes, blood, or body fluid are considered semicritical items and should be cleaned and then processed by a high level disinfectant such as Glutaraldehyde or sterilized between each patient use. The decontamination process for surgical instruments involves four steps: pre-rinsing, washing, rinsing, and sterilization (Kneedler & Darling, 1990). Multiple studies have observed the decontamination process; simply washing the blades with warm water is the least effective method (Roberts, 1973). They also showed that the use of 70% isopropyl alcohol solution was more efficient, but ineffective, at inhibiting bacterial growth. Furthermore, they demonstrated autoclaving was found to be the best method for sterilization of laryngoscope blades.

It is believed that with every reported case of disease transmission associated with endoscopes, the major cause was either from cleaning, disinfecting, or sterilizing the instrument (Abramson et al., 1993). This break down in the system is evident when discussing the laryngoscope handle. Although the laryngoscope handle does not contact the patient directly, the tip of the blade may contaminate it, which often touches the handle when folded in the closed position; hence the handle must also be considered a potential source of cross-infection. There are multiple places that pathogens can exist in the anesthesia work environment (Biddle, 2009).

In a study to survey methods of laryngoscope cleaning in healthcare facilities throughout Great Britain, results indicated that in one third of the facilities the handle is not cleaned at all, only 5% routinely autoclave the handle, and in 12% of the facilities

disposable laryngoscope blades are used (Esler, Baines, Wilkinson, & Langford, 1999). When asked, one third of responders stated they would not be prepared to put a laryngoscope, taken randomly from a room and considered ready for patient use, into their own mouth (Esler et al., 1999).

Although most anesthesia providers use appropriate precautions for the prevention of occupational transmission, the concept is not fully embraced. When surveyed whether or not common infection control practices were being implemented in their practice, anesthesia providers reported that only 24% adhere to mandatory CDC guidelines for the prevention of HIV, HBV, and HCV transmission (universal precautions) when patients were considered low risk (Tait & Tuttle, 1994). However, 88% always complied with the guidelines when presented with an HIV-infected patient (Tait & Tuttle, 1994).

Airway Equipment

Observation alone was not a reliable method for assessing the level of contamination on airway equipment. The first study that identified the presence of blood on anesthesia airway equipment following endotracheal intubation was conducted by Kanefield et al. (1989). All equipment that contacted the airway during each case was inspected for blood then submerged in a container of tap water for 5 minutes. The solution was tested for the presence of occult blood using a dry chemical reagent test strip. Of the 100 cases tested, 86 cases had equipment that was positive for bloody secretions. Thirty-six of those showed occult blood contamination, blood not visible to the human eye.

Since then, various studies (Table 1) have helped validate the premise that visible and occult blood is significantly present on laryngoscope blades and handles that are identified as ready for patient use. Some studies tested the equipment for the presence of blood using a guiac-based assay that can detect blood in concentrations as low as 1:10,000 (Morell et al., 1994). Some tested for the presence of blood using the modified version of the three-stage phenolphthalein blood indicator test (Phillips & Monaghan, 1997; Hall, 1994; Perry & Monaghan, 2001). Yet others used a Hemoccult Sensa card to determine the presence of blood (Ballin, et al., 1999) or erythrosine B dye, which stains blood proteins if present on surfaces (Miller et al., 2001). Although studies have indicated that anesthesia airway equipment and monitoring equipment can be contaminated with blood, no studies have determined if blood contamination actually represents a direct infection risk to patients or anesthesia providers. All of these tests have served as a rapid and inexpensive indicator system that potential contamination may actually exist.

Microbial Contamination

The proximity of the oropharynx and multiple body fluids to anesthesia equipment poses the potential for cross-infection. Maslyk et al. (2002) conducted a study to determine the amount of microbial growth that develops on the anesthesia machine after a full day of use in the operating room. Many organisms were shown to survive on the tabletops, such as coagulase-negative *Staphylococcus*, *Bacillus*, alpha *Streptococcus*, *Acinetobacter*, *Staphylococcus aureus*, and gram-negative rods. Some of these are known pathogenic organisms that can cause respiratory infections, especially in patients with compromised conditions (Williams et al., 2010).

Although studies advocate sterilization of laryngoscope blades following their use, this critical procedure may not occur at all times. Foweraker (1995) noted that four pediatric patients had developed serious *Pseudomonas aeruginosa* infections, in which one of the children died from nosocomial pneumonia and septicemia. After a thorough investigation of the environment, they concluded that the probable source of infection came from a single laryngoscope blade that was used on each child. Foweraker noted that the blade had dried secretions around the bulb and on the blade and when cultured, a moderate amount of *Pseudomonas aeruginosa* of the same phage type isolated from the blood culture of the child who had died. Foweraker concluded that a breach in the cleaning and disinfection process had occurred.

Wenzel and Edmond (1997) acknowledged that instruments themselves are sources of pulmonary infections with gram-negative organisms, such as *Pseudomonas aeruginosa* or *Serratia marcescens*. They concluded that if 1% to 5% of all bronchoscopic procedures are performed on patients with tuberculosis, then 460-2,300 patients might become exposed to the virulent pathogen each year if only 10% of the scopes are contaminated. They suggested that the major issue is identifying when bronchoscopes have been cleaned and disinfected adequately after use. Cleansing the instrument prior to immersion into glutaraldehyde was found to be a critical step in ensuring that these medical instruments are effectively disinfected.

Perhaps the most compelling reason for re-evaluating the cleaning, disinfection, and sterilization techniques of airway management equipment comes from the report of outbreaks of *Mycobacterium tuberculosis* infection following bronchoscopic procedures. Agerton et al. (1997) were concerned with nosocomial transmission of multidrug-

resistant tuberculosis (MDR TB) after eight patients with MDR TB were identified in South Carolina in 1995. All were resistant to 7 drugs and had matching DNA fingerprints. Community links were identified for five patients. However, no links were identified for the other three, except being hospitalized at the same community hospital and each had received a bronchoscopic procedure after one was performed on a patient with active MDR TB. Investigators concluded that inadequate cleaning and disinfection of the bronchoscope following each procedure led to cross-infection in these patients.

Methods to Improve Infection Control

Gadalla and Fong (1990) devised a clean way of performing an anesthesia induction to improve infection control in the operating room. First, the anesthetist puts on two pairs of clean gloves, induction is carried out, and then as soon as endotracheal tube placement is completed, the blade of the laryngoscope is held in the gloved hand and one outer glove is peeled off the hand and inverted over the dirty laryngoscope blade. The other glove is also removed. The anesthetist then has on a clean pair of gloves. This somewhat cumbersome technique ensures that the used laryngoscope blade never comes into contact with other equipment.

Tobin, Stevenson, and Hall (1994) developed a cost effective way to decrease the risk of laryngoscope handle contamination. Small plastic bags available from GEM Medical Industries INC. for $0.03 per unit can be placed over the laryngoscope handle and secured with tape. After the completion of each case the blade is sent for sterilization and the bag is disposed of, after which a new one is applied.

Disposable Laryngoscope Blades

In 2001, the United Kingdom's Department of Health recommended that all tonsillectomies be performed with disposable equipment to minimize the risk of prion transmission (Department of Health, 2001). They recommended that if laryngoscopy was to be performed, then disposable blade covers or disposable laryngoscope blades are used.

To help decrease the spread of nosocomial infections, the American Association of Nurse Anesthetists recommends the use of a disposable laryngoscope blade when possible (American Association of Nurse Anesthetists, 2010). Single-use airway equipment is designed to be used once and then discarded (Rowley & Dingwall, 2007). There may be concern about the quality of some of these devices because they are manufactured at a lower cost to justify their disposal.

Successful tracheal intubation depends on adequate visualization of the larynx, adequate illumination of the larynx, and operator skill. Therefore, anesthetists may be concerned about difficulties in obtaining a view of the glottis with single-use laryngoscope blades. Amour et al. (2010) conducted a study of 1,072 adult patients undergoing general anesthesia under emergency conditions and requiring rapid sequence induction. The patients were randomly assigned to either single-use metal or reusable metal laryngoscope blades on a weekly basis. Both groups were similar in their main characteristics and risk factors for difficult intubation. The purpose of the study was to determine the rate of failed intubations. The researchers found that the rate of failed intubation was significantly decreased with the single-use metal blades at the first attempt compared with reusable blades (2.8% versus 5.4%, $P < 0.05$).

Single-use blades are, however, manufactured with different designs and materials (Table 2). The plastic single-use laryngoscope blade is reported to be less efficient than a metal reusable blade during a rapid sequence induction of anesthesia (Amour et al., 2006). Similar results have been reported by Jabre et al. (2007) and Galinski et al. (2003). This is in part due to the increase in flexibility that is seen with disposable plastic laryngoscope blades (Goodwin et al., 2006). In routine use, the single-use laryngoscope blade appears to be an efficient device, but it has been recommended to always have conventional reusable laryngoscope blades reserved for difficult intubations (Shahiari et al., 2007).

A comparison of three laryngoscopes, including a standard stainless steel Macintosh 3 blade, the same blade with a disposable cover applied and a disposable Macintosh 3 blade in reference to the ease of intubation (Table 3) using a high-fidelity human patient simulator, was conducted (Anderson et al., 2006). The high-fidelity human patient simulator can provide a range of intubation conditions from easy to impossible. Anesthetists performed laryngoscopy with each of the three laryngoscopes in both easy and difficult simulator intubation settings. For the easy setting, 34% ($P = 0.001$) of anesthetists graded laryngoscopy more difficult with the covered laryngoscope and 22% ($P = 0.008$) with the disposable laryngoscope considered laryngoscopy more difficult than with the standard reusable metal laryngoscope. Sixty-nine percent ($P < 0.001$) of anesthetists in this study found laryngoscopy more difficult with the disposable laryngoscope blade in the difficult simulator setting. Although a high-fidelity patient simulator allows for standardized, reproducible intubating conditions, there is debate as to whether it is an adequately validated tool for assessment of anesthetists. According to

Rowley and Dingwall, “despite reservations about induced harm and the unknown risk of an iatrogenic disease, most clinicians would want single-use devices used on themselves and their family if they were patients” (2007, p. 569).

Successful intubation requires appropriate skill, but also depends heavily on access to functionally good equipment. A study looking at success rates and duration of laryngoscopy using disposable laryngoscope blades in children found no significant difference compared to the metallic reusable laryngoscope (Darabi, Mireskandari, & Salamati, 2008). A similar study determined that there was higher user satisfaction with the metal disposable blades ($p < 0.001$) (Sudhir et al., 2007). There was a statistically significant ($p < 0.01$) increase in illumination (Table 4) when a disposable blade was used (Cheung et al., 2007).

Summary

Manipulation of a patient’s airway, as with intubation procedures, may often be bloody. Several studies suggest the current procedures for the cleaning, disinfecting, sterilization and handling of reusable laryngoscope blades and handles may be ineffective, or that there may be poor compliance with established protocols. The devastating spread of communicable diseases over the past few decades has resulted in the development of guidelines to be used to protect patients as well as health care workers from potential exposure to blood-borne pathogens. The need for continued vigilance and evaluation of airway management equipment is evident. Although the concept of disposable laryngoscope blades is appealing, several previously published studies reported less user satisfaction than with the reusable laryngoscope blades. The main advantages of using a disposable laryngoscope blade involve infection control, cost

(Table 5) and bright fiberoptic lighting. Ultimately, the decision to use a disposable laryngoscope blade over a reusable laryngoscope blade will come down to the actual anesthesia provider or accrediting and regulatory bodies, institutions and individual preference.

Table 1

Studies Investigating the Presence of Visible and Occult Blood on Laryngoscope Blades and Handles

Author/Date	Design	Sample	Outcome	Interventions	Results	Limitations
Williams et al. (2010)	Randomized blinded Study	192 specimens from 64 laryngoscope handles deemed 'ready for patient use' in the anesthetic rooms of 32 operating theatres were semi-quantitatively assessed for bacterial contamination	Bacterial contamination and occult blood	Laryngoscope handles	One or more species of bacteria were isolated from 55(86%) of the handles; no occult blood contamination was demonstrated	Inadequate sensitivity of the detection of blood methods employed; sites B and C were swabbed for microbial contamination prior to sampling for occult blood
Phillips & Monaghan (1997)	Prospective observational study	Sixty-five laryngoscope blades and handles identified as ready for patient use were observed for visible blood and tested for occult blood	Presence of occult blood	Visible and occult blood on laryngoscope blades and handles that were identified as ready for patient use	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	Contamination could have happened after the sterilization
Perry & Monaghan (2001)	Prospective observational study	336 types of operating room equipment	Presence of occult blood		110 (32.7%) tested positive for occult blood using the 3 stage phenolphthalein test	Contamination could have happened after the sterilization
Esler et al. (1999)	Survey	Of the 289 questionnaires sent out, 239 were returned	Cleaning methods	Survey methods of laryngoscope cleaning in units through Great Britain	One third of the units the handle is not cleaned at all; only 5% routinely autoclave the handle and in 12% of the units, disposable laryngoscopes are used; one third would not be prepared to put a cleaned blade into their mouth	Conducted outside the United States

Table 2

Studies Investigating Failed Intubation with Disposable Laryngoscope Blades

Author/Date	Design	Sample	Outcome	Interventions	Results	Limitations
Amour et al. (2010)	Randomized clinical trial	1,072 adult patients undergoing general anesthesia under emergency conditions and requiring rapid sequence induction (RSI)	Failed Intubation	Single-use metal laryngoscope blade, reusable metal laryngoscope blade	Significantly more failed intubation with reusable blades (5.4 versus 2.8%, $p<0.05$).	Not blinded
Amour et al. (2006)	Cluster Randomized clinical trial	284 adult patients were randomly assigned on a weekly basis to either plastic single use or reusable metal blades	Failed Intubation	Plastic single-use laryngoscope blades, Metal reusable laryngoscope blades	Significantly more failed intubations on the first attempt with the plastic single use laryngoscope blade (17% vs. 3%, $p<0.01$).	Not blinded
Galinski et al. (2003)	Prospective observational study	119 intubations were perfumed using disposable blades and 100 intubations were performed using traditional metal blades on the first attempt	Failed Intubation	Vital View disposable laryngoscope blades	Of the 119 first attempts using the disposable blades only 12 blade changes had to be performed before successful intubation	Not blinded, user bias
Shahriari et al. (2007)	Prospective study	200 patients that were randomly divided into two groups	Failed Intubation	Disposable laryngoscope blade and the reusable laryngoscope blade	The disposable laryngoscope blade group had a 14% incidence of failed intubation and 21% incidence of prolonged intubation	Varying levels of experience among the anesthetists
Jabre et al. (2007)	Observational before-and-after study	Intubated with metallic blade (594/1177) and with a plastic blade (583/1177)	Failed Intubation	Metallic blade plastic blade	The first-attempt intubation success rate was higher in the metallic blade group; the incidence of difficult intubation was lower when metallic blades were used; a good laryngeal view was more frequently observed with metallic blade use	Not blinded, user bias

Table 3

Studies Investigating the Ease of Use of Disposable Laryngoscope Blades

Author/Date	Design	Sample	Outcome	Interventions	Results	Limitations
Anderson et al. (2006)	Randomized 20 unblinded study	32 anesthetists with between 11 months and 25 years of experience using a high-fidelity simulator	Ease of use	Standard reusable laryngoscope blades; standard reusable laryngoscope blades with disposable blade covers; disposable laryngoscope blades	"Easy" setting: laryngoscopy more difficult with the covered blade (p= 0.001) and the disposable blades; "difficult" setting: laryngoscopy more difficult with both the covered blades (22%, p=0.008)and the disposable blades (69%, p<0.001)	Although a high-fidelity patient simulator allows for standardized, reproducible intubating conditions there is debate as to whether it is an adequately validated tool for assessment of anesthetists
Sudhir et al. (2007)	Manikin based observational study	50 experienced anesthetists	Ease of use	Disposable and standard re-usable Miller size 1 blades	Better user satisfaction with metal disposable blades (p<0.001); greater force needed with plastic blades	Not blinded, user bias
Rassam, et al. (2005)	Observational study	Fifty anesthetists were recruited to use 20 different laryngoscope blades (one metal re-usableblade, five metal single-use blades and 14 plastic single-use blades)	Ease of attachment of the blade to the handle, illumination, view of the larynx, and satisfaction for clinical use; the peak force applied and time to achieve the grade I Cormack and Lehane view were also measured.		Ease of attachment, illumination, view, clinical use, force and duration were all significantly affected by the blade used (p < 0.0001 for all six); two plastic blades provided a poor view and increased the duration of laryngoscopy	Not blinded, user bias

Table 4

Studies Investigating Flexibility and Light Emission of the Disposable Laryngoscope Blade

Author/Date	Design	Sample	Outcome	Interventions	Results	Limitations
Goodwin et al. (2006)	Observational study	Eleven Miller 1 blades; 3 new samples of each blade	Flexibility and light emission	Disposable and re-usable Miller 1 Blades	There was a significant difference in flexibility between metal and plastic blades ($p=0.006$); an eightfold difference in level of illumination provided	No standard set as to the degree of flexibility that is acceptable
Cheung et al. (2007)	Observational study	Fifty-one laryngoscopes	Illumination	New Batteries, new bulb, new batteries and new bulb, and attachment of a disposable blade	Fourteen percent of laryngoscopes (7/51) at baseline met the minimal illumination criterion	All measurements were made from one ambulance base; results may not be generalizable

Table 5

Studies Investigating Cost, User Satisfaction and Provider Preference

Author/Date	Design	Sample	Outcome	Interventions	Results	Limitations
Romig (2005)	Methodical Problem analysis	17 studies	Disposable laryngoscope blades or reusable laryngoscope blades	Cost, user satisfaction, quality management, risk management	Decision to transition to disposable equipment	EMS practitioners
Rowley & Dingwall (2007)	Survey, focus group and interview methodologies	Eight English NHS Trusts covering 12 hospital sites was selected; twenty-three interviews were completed	Quality and efficacy of single-use laryngoscope blades	Provider preference	Despite reservations about induced harm and the unknown risk of an iatrogenic disease, most clinicians would want single-use devices used on themselves and their family if they were patients	

Chapter Three: Methodology

This chapter includes a description of the design, setting, and sample for the study. This is followed by a discussion of the methods and procedures for the study, including the protection of human subjects.

Study Design

This study used a one group before and after design with an 11 item anonymous questionnaire obtained from anesthesia providers prior to implementation of the practice change. This questionaire can be found in Appendix C. Fixed alternative and open ended questions were used in the survey. This questionnaire was developed by Melissa Machan, the principal investigator. The anesthesia providers were asked by the principal investigator three months later to complete the same 11-item anonymous questionaire. The study ran for three months.

Sample

A convenience sample consisted of all anesthesia providers at a large urban hospital in South Florida that agreed to voluntarily participate and sign the informed consent. The participants included 7 anesthesiologists and 5 certified registered nurse anesthetists. The anesthesia providers' experience ranged in their specialty. Participitants included both males and females of different ethnicities and age. All providers were over 18 years of age.

Setting

This study took place at a large urban hospital in South Florida. This hospital is a 264 bed full-service facility that has been providing a range of healthcare services to residents of Plantation and Central Broward County for 40 years. It is fully accredited by The Joint Commission and specializes in comprehensive adult services, minimally invasive surgery, and adult medical care.

Data Collection Procedure

Once Institutional Review Board (IRB) approval and written consent (Appendix A) was obtained, participants were asked to complete an anonymous one-page questionnaire on their knowledge and practice regarding disposable laryngoscope blades. This was done during a monthly group meeting. Upon completion, all questionnaires were deposited in a collection box located at the exit doorway. Immediately following the completion of the questionnaire, participants were given an evidence based article (Appendix B) to read that was written by the primary investigator regarding this literature review. This evidence based intervention was designed to give the anesthesia providers the best information about infection control practices of laryngoscope blades. The intended outcome of this intervention was to increase the use of disposable laryngoscope blades at this facility thereby improving patient safety. This project took place over three consecutive months. Final data collection, in which the participants completed the same anonymous questionnaire in a similar manner, was done 3 months following the pre-intervention questionnaire. The participants were asked not to use any reference material or discuss questionnaire items with their colleagues.

Inventory of the disposable laryngoscope blades was collected at the start of the project (pre-intervention), at one month, and then again at 3 months. Inventory was collected by the primary investigator by totaling the amount of daily disposable blades utilized by all providers each day. All general anesthetics requiring intubation on adults were counted, as well as how many used disposable laryngoscope blades each day for one week. Appendix E displays the tool that was used to count how many disposable blades were utilized. This was done one week prior to the collection of the questionnaire, the first week of the second month, and again the first week of the third month.

Instrumentation

The data collection instrument was an 11-item investigator-developed questionnaire regarding the anesthesia provider's knowledge of and experience with the use of disposable laryngoscope blades. Besides some standard demographical data, the questionnaire asked, "Which best describes the amount of time you use the single-use laryngoscope blade?", "If you have used the Single-use laryngoscope blade, did you find it easy to use?", "If you routinely use the Single-use laryngoscope blade, how many times would you say that you had to change to a traditional multi-use laryngoscope blade?", "What best describes your reason for NOT using a single-use laryngoscope blade?" and "Please list any complications you have encountered in using a single-use laryngoscope blade.".

The intervention was an evidence based article that was written by the primary investigator about the best and most recent clinical evidence to impact patient safety during laryngoscopy. This article was accepted for publication by the AANA Journal,

the official scholarly journal of the American Association of Nurse Anesthetists. The tentative publication date is August 2012 (Machan, 2012).

Feasibility

The resources needed to ensure project completion included the facility keeping the disposable laryngoscope blades stocked in the operating rooms. The disposable laryngoscope blade cost $4.35 each and this value is charged to the patient so that there are usually no budgetary considerations. With a lower overall cost than the purchase, maintenance, cleaning, and sterilization of the reusable laryngoscope blade, this financial plan justified the need, feasibility, and sustainability of the proposed project.

Protection of Human Subjects

Institutional Review Board approval was obtained from the University of North Florida once approval from the participating clinical site was obtained. Once this was formally approved, data collection began. All anonymous data collected was recorded on the data collection sheet and transferred to a spreadsheet (Appendix D). Neither the data collection sheets nor the spreadsheet had identifying information. All data was handled in an aggregate manner. There was no need to connect participant responses from pre-test to post-test, so there was no master list or any identifiying information. The consent that was signed by the participant prior to starting the project was scanned into the University of North Florida's secure server, after which the paper consent was shredded and discarded. There was no link between consent and participant responses. The raw data will be kept for three years.

Data Analysis

All raw data entered into the computer was checked for errors and then analyzed using SPSS statistical software (version 17.0, 2007, Chicago, Il) with statistical significance determined at $p < 0.05$. Descriptive statistics were also used. The Wilcoxon Signed-Rank Test was performed in order to examine between group differences in the perception and use of disposable laryngoscope blades from pre-test to post-test. This evidence based practice project was looking to see if there was a change in anesthesia practice as a whole. In the event that participants dropped from the study, it did not majorly impact the project since only overall change was measured.

Chapter Four: Results

This chapter describes the study population using mean scores and frequency of the variables. Analyses were executed using SPSS statistical software (version 17.0, 2007, Chicago, IL) with statistical significance determined at $p \leq 0.05$. Data were analyzed using descriptive statistics and the Wilcoxon Signed-Rank Test to determine group differences between pre-test to post-test assessments.

The research questions were as follows:

Research Questions

1. What is the perception of anesthesia providers regarding ease of use and complications of disposable laryngoscope blades before and after the in-service program?
2. What percentage of anesthesia providers use disposable laryngoscope blades before and after the in-service training program?
3. How many disposable laryngoscope blades were used in the facility throughout the three months project?
4. What is the anesthesia providers' evaluation of ease of use of the disposable laryngoscope blade?
5. What are the providers' rationales for non-use of a disposable laryngoscope blade after the in-service program?
6. What complications did anesthesia providers encounter when using a disposable laryngoscope blade?

A total of 12 anesthesia providers (100%) participated in the evidence based practice project. Four of the 12 providers (33%) were women and 8 (67%) were men. One (8.33%) of the anesthesia providers had been in practice between 1 and 5 years. Two (16.67%) of the anesthesia providers have been in practice between 5 and 10 years and 9 (75%) have been practicing for greater than 10 years. Fifty-eight percent of the providers described their client base as adults. Twenty-five percent of the providers described their client base as children and 17% of the providers described their client base as obstetrical. All of the anesthesia providers were aware of single-use laryngoscope blades prior to the intervention and all of them have used it at some point prior to the intervention. Each of the anesthesia providers stated that the plastic laryngoscope blade is the type of single-use laryngoscope blade that is made available at their facility.

Pre-intervention Results

Prior to the participants being given an article to read about this literature review, written by the primary investigator, 33% of the providers said they always use the single-use laryngoscope blade. Thirty-three percent of the anesthesia providers said they use the single-use laryngoscope blade 75% of the time. Seventeen percent of the anesthesia providers said they use the single-use laryngoscope blade 50% of the time. Seventeen of the anesthesia providers said they use the single-use laryngoscope blade 25% of the time, whereas none of the anesthesia providers said that they never use the single-use laryngoscope blade.

Of those who had used the single-use laryngoscope blade, 83% found it easy to use. Of those that routinely used the single-use laryngoscope blade, 8.33% said that they have never had to change to a traditional multi-use laryngoscope blade during laryngoscopy.

Eighty-three percent said that they had to change to a traditional multi-use laryngoscope blade during laryngoscopy < 25% of the time.

Sixty percent of anesthesia providers described performance as their reason for not using a single-use laryngoscope blade. Forty percent of anesthesia providers described something other than availability, expense, and performance as their reason for not using a single-use laryngoscope blade. Two of the anesthesia providers left this question blank.

When asked to list any complications encountered in using a single-use laryngoscope blade, 50% answered none. Some individuals, however, listed flexibility, broke while attaching, limited view, bulky, environmental waste or battery life as a complication.

Post-intervention Results

After the participants were given an article to read about this literature review, written by the primary investigator, they were allotted 3 months to experiment with the disposable blades. At that time, 33% (N = 4) of the providers said they always use the single-use laryngoscope blade. Thirty-three percent of the anesthesia providers said they use the single-use laryngoscope blade 75% of the time. Seventeen percent of the anesthesia providers said they use the single-use laryngoscope blade 50% of the time. Eight percent of the anesthesia providers said they use the single-use laryngoscope blade 25% of the time, whereas 8% of the anesthesia providers said they never use the single-use laryngoscope blade. These results are listed in Figure 1.

Which best describes the amount of time you use the single-use laryngoscope blade:	**Preintervention**	**Postintervention**
Always	33.33%	33.33%
75%	33.33%	33.33%
50%	16.67%	16.67%
25%	16.67%	8.33%
Never	0.00%	8.33%
If you have used the Single-use laryngoscope blade, did you find it easy to use?		
Yes	83.33%	91.67%
No	16.67%	8.33%
If you routinely use the Single-use laryngoscope blade, how many times would you say that you had to change to a traditional multi-use laryngoscope blade?		
Never	8.33%	8.33%
<25% of the time	83.33%	83.33%
<50% of the time	0.00%	0.00%
<75% of the time	0.00%	0.00%
Not Applicable	8.33%	8.33%
What best describes your reason for NOT using a Single-use Laryngoscope blade.		
Not available to you	0.00%	8.33%
Expense	0.00%	0.00%
Performance	60.00%	25.00%
Other	40.00%	66.67%

Figure 1. Survey results pre- and post-intervention.

Of those who have used the single-use laryngoscope blade, 92% found it easy to use. Of those who routinely use the single-use laryngoscope blade, 8% said that they have never had to change to a traditional multi-use laryngoscope blade during laryngoscopy.

Eighty-three percent said that they had to change to a traditional multi-use laryngoscope blade during laryngoscopy < 25% of the time. Eight percent said the question was not applicable. Figure 2 shows the difference in percentage of anesthesia providers that found the disposable laryngoscope blade easy to use during pre- and post-intervention. A Wilcoxon Signed Ranks Test showed that a 3-month period to experiment with disposable laryngoscope blades after the intervention did not elicit a statistically significant change in provider perception of the ease of use ($Z = -1.00$, $p = 0.317$).

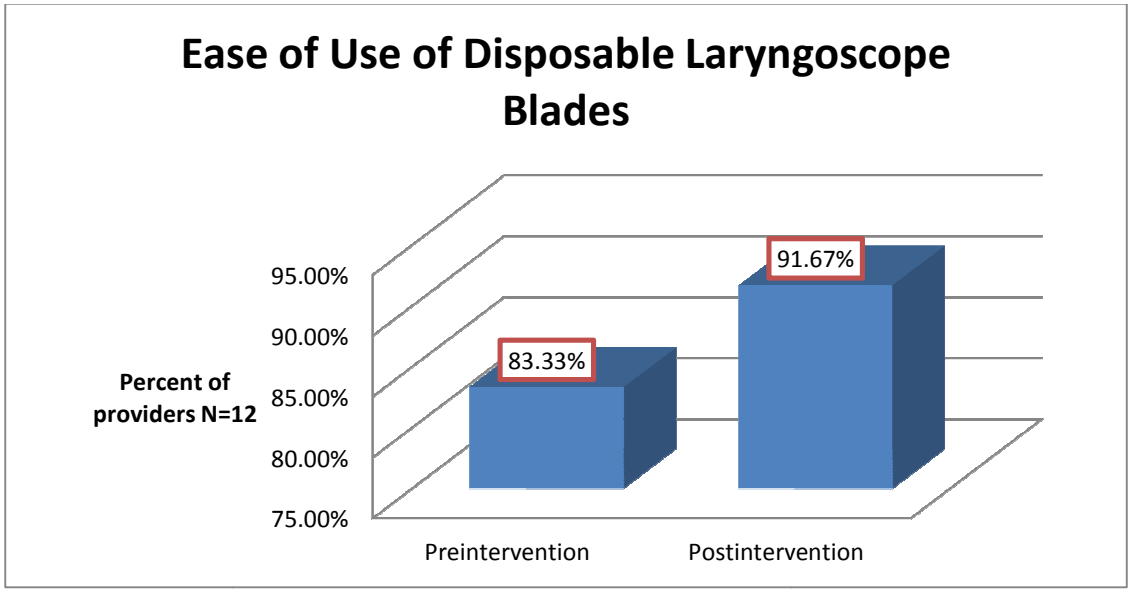

Figure 2. Ease of use of disposable laryngoscope blades.

Eight percent of anesthesia providers described availability as their reason for not using a single-use laryngoscope blade. Twenty-five percent of anesthesia providers described performance as their reason for not using a single-use laryngoscope blade. Sixty-seven percent of anesthesia providers described something other than availability, expense, and performance as their reason for not using a single-use laryngoscope blade.

Figure 3 shows the difference in percentage of anesthesia providers who found performance of the disposable laryngoscope blade the reason for not using it pre- and post-intervention.

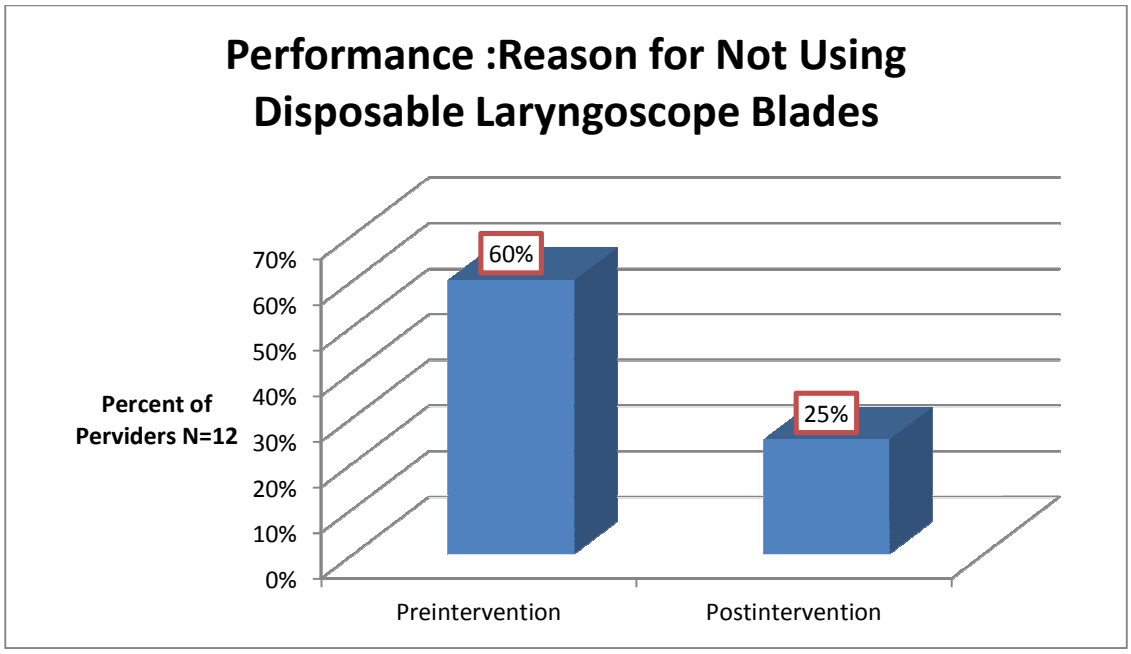

Figure 3. Performance as reason for not using disposable laryngoscope blades.

When asked to list any complications encountered when using a single-use laryngoscope blade, 50% answered none. However, some listed flexibility, wide, and bulky as a complication.

Inventory of Disposable Laryngoscope Blades

A total of 30 general anesthetics requiring intubation were recorded in the week prior to the dissemination of the intervention article. Of those, 12 (40%) intubations were performed utilizing a disposable laryngoscope blade. There was a substantial increase in the number of disposable laryngoscope blades used in the second month. A total of 48 general anesthetics requiring intubation were recorded over one week in month 2, after

the dissemination of the intervention article. Of those, 31 (65%) intubations were performed utilizing a disposable laryngoscope blade. A total of 24 general anesthetics requiring intubation were recorded over one week in the third month after dissemination of the intervention article. Fifteen (63%) of those intubations were performed utilizing a disposable laryngoscope blade. The percentages are graphed in Figure 4 to illustrate the amount of change from one month to another. . A single proportion Z-Test showed that the increase in use of disposable laryngoscope blades after the intervention was statistically significant (Z=2.046, p=0.041).

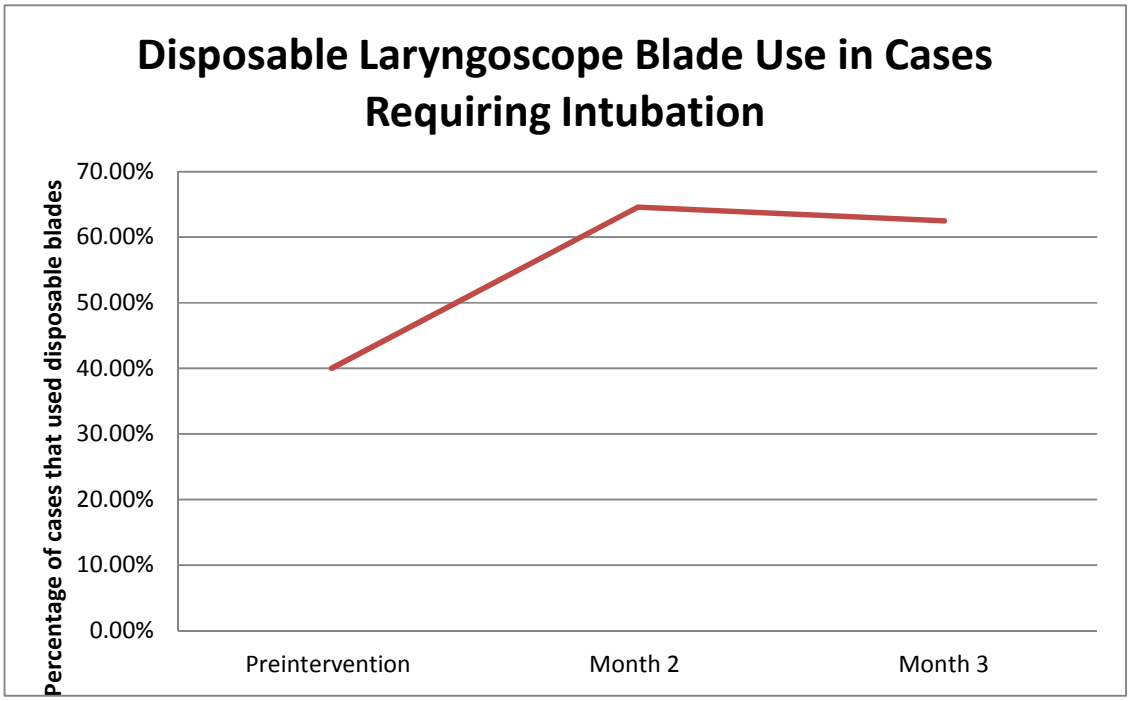

Figure 4. Disposable laryngoscope blade use in cases requiring intubation.

Chapter Five: Discussion

This chapter provides a discussion of the study findings relevant to anesthesia providers' use of disposable laryngoscope blades, as well as interventions and lessons learned in the process. Implications for evidence based practice and future research are also presented.

Discussion of Level of Improvement

Although there was not a statistically significant difference in the way anesthesia providers described their use of disposable laryngoscope blades, there is a change in practice noted from the questionnaire as well as an increase in the amount of disposable laryngoscope blades used following the intervention. The 23% increase in disposable laryngoscope blade use over the three months reflects the practice change of the anesthesia providers. A greater number of anesthesia providers stated that they felt disposable laryngoscope blades were easy to use at the completion of the project. Pre-intervention, 83% of providers found it easy to use, whereas 92% of anesthesia providers found it easy to use post-intervention. Because of the small sample size (N = 12), it is difficult to conclude how significant these results are. However, if you only look at those who did not find the disposable laryngoscope blade easy to use pre-intervention (N = 2), there was a 50% increase in how easy to use the providers found the disposable laryngoscope blades to be post-intervention (N = 1).

There was a big change in providers' reasons for not using a single-use laryngoscope blade. Pre-intervention, providers mainly chose performance (60%) and other (40%) as their reason. However, 8% of providers cited availability, 25% cited performance and 67% cited other as their reason for not using disposable laryngoscope blades post-intervention. This change might be attributed to how comfortable anesthesia providers became with the disposable laryngoscope blades during the 3 months post-intervention. With increased use, there was a perceived decrease in performance issues with the disposable laryngoscope blade.

Availability issues related to not having appropriately sized disposable laryngoscope blades. From time to time, a Macintosh 4 blade or Miller blades are the best choice for adult intubation. Macintosh 3 blades are the only disposable laryngoscope blade available at this facility. One participant stated they never use the disposable laryngoscope blade on the postintervention questionnaire. One possibility of this outcome could be attributed to the disposable laryngoscope blades that are available on site. If this anesthesia provider routinely worked in pediatrics and appropriate sized disposable laryngoscope blades are not available then they would never have the opportunity to use it.

Strengths and Weaknesses

The strengths of this project are the increased use of the disposable laryngoscope blade and the impact that has on patient safety. The weaknesses of this project are the small sample of anesthesia providers who were given the intervention (N=12), the duration of the project and the possibility that the participants did not read the intervention article.

One of the major limitations of the study deals with the answers on the questionnaire. When asked which best describes the amount of time a provider uses the disposable laryngoscope blade, the answer key only allowed for always or the next level of measurement which was 75% of the time. The difference between the two answers was too large and therefore did not allow for any level of improvement. Providers communicated that they always use a disposable blade except when there is a difficult intubation. They therefore cannot choose "always" so the next closest is "75% of the time", but in reality might have been 99% of the time.

Implications for Future Research

This relatively short evidence based project showed a change in practice and can serve as a pilot study for a larger geographical study. The project should be continued and expanded to include multiple facilities to see if there is consistency in the findings. Future research will need to further investigate the effectiveness of different types of disposable laryngoscope blades (metal vs. plastic) as well as different sizes and in different patient populations. This project focused on plastic Macintosh 3 disposable blades in the adult non-obstetrical patient because that is what was available in the facility in which the project took place.

Implications for Clinical Practice

The recommendation for the site at which the project was conducted is to convert to all disposable laryngoscope blades. Metal reusable laryngoscope blades should remain available for a difficult intubation. Because only Macintosh 3 blades are available at present in this facility, it is my recommendation to include Macintosh size 4 and Miller size 2, 3, and 4 in the inventory. In order for these recommendations to happen it would

be necessary that the chief of anesthesiology be on board. This could also be expanded beyond anesthesia and incorporate the emergency room personnel as well as emergency medical services. Just as we have seen with other airway equipment (LMA's oral airways), the move to disposable products is in our future as the evidence clearly states that it is a better choice for protecting patients.

Conclusion

It is well documented that the current procedures for the cleaning, disinfecting, sterilizing, and handling of reusable laryngoscope blades may be ineffective, or that there may be poor compliance with established protocols. The disposable laryngoscope blade is available as a method to eliminate the potential breakdown in that process. Although the concept of disposable laryngoscope blades makes sense, anesthesia providers have been reluctant to fully embrace its use in the past. This evidence based project has shown that despite apprehension, a change in practice is evident after dissemination of the best and most recent clinical evidence regarding laryngoscope blades. Improved patient outcomes will result. The increased use of disposable laryngoscope blades that was seen in this project was due to an effective intervention that has now had an impact on patient care.

Appendix A: Consent to Participate

Dear Participant,
Hi my name is Melissa Machan and I am a graduate student at the University of North Florida conducting a research study on disposable laryngoscope blades. This study will attempt to determine the perceptions of anesthesia providers regarding the use of a disposable laryngoscope blade, their frequency of use, their evaluation of ease of use, and any complications encountered when using the disposable blade before and after an in-service program designed to increase use of disposable blades.

If you take part in my project, you will fill out a one page pre and post anonymous questionnaire and read a three page article. We expect that participation in this study will take about 30 minutes of your time over a 3 month period. Your responses will be anonymous. No one other than Melissa Machan will see your responses and your responses will not be tied back to you. Although there are no direct benefits to you or compensation for taking part in this study, others may benefit from the information we find from the results of this study. Additionally, there are no foreseeable risks for taking part in this project. Participation is voluntary with no penalties for not responding to a question or ceasing participation. If you choose not to take part or to withdraw from this study, there will be no penalty or loss of benefits to which you would otherwise receive. If you have any questions or concerns about this project, please contact me or my professor. If you have questions about your rights as a participant, you may contact the University of North Florida's Institutional Review Board Chairperson, Dr. Katherine Kasten, at

Thank you for your consideration.
Sincerely,

Melissa Machan
Phone:
Email:

Dr. W. Patrick Monaghan
Phone:
Email:

I _____(print name) attest that I am at least 18 years of age and agree to take part in this study. A copy of this form was given to me to keep for my records.

Signature: _____ Date:_____

Appendix B: Intervention Article

Infection Control Practices of Laryngoscope Blades: A Review of the Literature

Melissa Machan, CRNA, ARNP

Abstract

Current procedures for cleaning anesthesia airway equipment as assessed by the presence of visible and occult blood on laryngoscope blades and handles as labeled "ready for patient use" has been reported to be ineffective. Human Immunodeficiency Virus (HIV) and Hepatitis B (HBV) are two commonly seen pathogens which frequently are found in the healthcare setting. It has been shown that HBV can survive on a dry surface for at least seven days and both HIV and HBV are transmitted via blood. The potential for cross contamination from airway equipment to patient has been shown in several studies. In order to prevent further potential infections, it should be ascertained as to why anesthesia providers are not all using disposable laryngoscope blades.

The purpose of this literature review is to determine the use and infection control practices of disposable laryngoscope blades. Their frequency of use, their evaluation of ease of use, and any complications encountered when using the disposable blade is reviewed as well as the perceptions of anesthesia providers regarding disposable laryngoscope blades.

Introduction

Nosocomial infections affect 1.7 million people and contribute to 99,000 deaths annually[1] as well as cost hospitals $6.7 billion per year in the United States.[2] These costs will not only be burdensome to hospitals, but also felt by the average person. The greater the payout of insurance companies, the higher the standard premium will be. In view of these facts, healthcare providers should be doing everything to ensure that infections including human immunodeficiency virus (HIV) and Hepatitis B (HBV) are not spread unknowingly by contaminated equipment. Since contaminated anesthesia airway equipment has a potential to transmit pathogenic organisms, anesthesia providers must be certain that reusable airway equipment such as laryngoscope blades are clean or use disposable equipment.

A cause and effect relationship between contaminated anesthesia airway equipment and nosocomial infection is difficult to establish.[3] However, blood is an excellent environment for all forms of pathogenic organisms to flourish. It is easy, therefore, to theorize that nosocomial infections could potentially result from visible and occult blood present on reusable anesthetic airway equipment. Since these infections often have major economic and health related consequences, prevention is a top priority for hospitals and insurance companies.

In an era of deadly communicable diseases it is easy to see the importance of proper cleaning and sterilization. Intubation of the trachea using reusable equipment creates a risk for cross-contamination because no perfect decontamination procedure exists.[4] It has been established in multiple studies that the current cleaning and sterilization techniques for reusable anesthetic airway equipment are ineffective at removing all remnants of blood.[3-9] Disposable laryngoscope blades are available to prevent potential cross contamination. These single use disposable laryngoscope blades have come with mixed reviews from anesthesia providers.[10-17]

This review will appraise the literature regarding infection control practices in hospitals in general and for anesthesia airway equipment in particular. This will include a historical perspective on infection control practices with respect to reusable laryngoscope blades, the advent of disposable laryngoscope blades, and a synthesis of the available evidence with respect to provider preference and usability of reusable versus disposable blades.

Standard search procedures were used to locate published studies. Electronic databases searched were CINAHL, Medline, PubMed, and Cochrane library, using the key terms disposable laryngoscope blade, single-use laryngoscope blade, reusable laryngoscope blades, and laryngoscopy. The search was limited to the English language. Although this strategy captured a large number of studies, very few of them dealt with anesthesia provider preference and usability.

History and Review of the Literature

Favorable environmental conditions were initially established for hospital settings in the mid-twentieth century. Spaulding[18] devised a rational approach to disinfection and sterilization of patient care items and equipment. He believed that the nature of disinfection could be mastered more readily if instruments and items for patient care were divided into three categories according to the degree of risk of infection involved in the use of these items. The three categories of items were critical (Items that enter sterile tissue or the vascular system), semicritical (Items that come in contact with nonintact skin or mucous membranes), and noncritical (Items that come in contact only with intact skin). This classification scheme was so clear and logical that it has been used by the Association for Professionals in Infection Control and Epidemiology,[19] Centers for Disease Control (CDC),[20] and Occupational Safety and Health Administration.[21]

In 1987, the CDC made recommendations for prevention of HIV transmission in health care settings suggesting that medical devices or items that contact intact mucous membranes should be sterilized or receive high-level disinfection.[22] They further recommended that items should be thoroughly cleaned before being exposed to the germicide. These recommendations have been adopted by many including the Association of Operating Room Nurses.[23]

In the mid 1980's, identification of HIV in blood and body fluids motivated researchers to look at the potential risk that blood borne pathogens presented to healthcare providers. Laboratory analysis of serum or plasma specimens scheduled to be discarded by a hospital laboratory demonstrated that 1.1% were positive for HIV, 4.9% were positive for HBV, and 5.7% were positive for both.[24] If inanimate objects become contaminated with Hepatitis B virus and are not properly cleaned and disinfected or sterilized then these contaminated objects may contribute to disease transmission for periods of time up to one week and possibly longer.[25]

According to the Association of Operating Room Nurses,[23] reusable anesthesia equipment such as laryngoscope blades that come into contact with mucous membranes, blood, or body fluid are considered semicritical items and should be cleaned and then processed by high level disinfection such as Glutaraldehyde or sterilized between

each patient use. The decontamination process for surgical instruments involves four steps: pre-rinsing, washing, rinsing, and sterilization.[26] Multiple studies have looked at the decontamination process. Simply washing the blades with warm water is the least effective method.[27] The use of 70% isopropyl alcohol solution was more efficient, but ineffective at inhibiting bacterial growth.[27] Autoclaving was found to be the best method for sterilization of laryngoscope blades.[27]

It is believed that with every reported case of disease transmission associated with endoscopes, the major cause was either in cleaning, disinfecting, or in the sterilization of the instrument.[28] This break down in the system is evident when discussing the laryngoscope handle. Although the laryngoscope handle does not contact the patient directly, the tip of the blade may contaminate it, which often touches the handle when in the folded closed position; hence the handle must also be considered a potential source of cross-infection. There are multiple places that pathogens can exist in the anesthesia work environment. [29]

In a study to survey methods of laryngoscope cleaning in health care facilities through Great Britain, results indicated that in one third of the facilities the handle is not cleaned at all, only 5% routinely autoclave the handle and in 12% of the facilities disposable laryngoscope blades are used. When asked, one third of responders stated they would not be prepared to put a laryngoscope, taken randomly from a room and considered ready for patient use, into their mouth.[30]

Although most anesthesia providers use appropriate precautions for the prevention of occupational transmission, the concept is not fully embraced. When patients were considered low risk, only 24% of anesthesia providers surveyed said they adhere to mandatory CDC guidelines for the prevention of HIV, HBV, and HCV transmission (universal precautions).[31] However, 88% always complied with the guidelines when presented with an HIV-infected patient. [31]

Observation alone is not a reliable method for assessing the level of contamination on airway equipment. Among others, one study that identified the presence of blood on anesthesia airway equipment following endotracheal intubation was conducted by Kanefield, Munro and Eisele in 1989.[32] All equipment that contacted the airway during each case was inspected for blood then submerged in a container of tap water for 5 minutes. The solution was tested for the presence of occult blood using a chemstrip. Of the 100 cases tested, 86 cases had equipment that was positive for bloody secretions. Thirty-six of those showed occult blood contamination, blood not visible to the human eye.

Since then, various studies have helped validate the premise that visible and occult blood is significantly present on laryngoscope blades and handles that are identified as ready for patient use. Some studies tested the equipment for the presence of blood using a guiac based assay that can detect blood in concentrations as low as 1:10,000.[33] Some tested for the presence of blood using the modified version of the three-stage phenolphthalein blood indicator test[3,6,34]. Yet others used a Hemoccult Sensa card to determine the presence of blood[5] or erythrosine B dye, which stains proteins if present on surfaces.[7] Although studies have indicated that anesthesia airway equipment and monitoring equipment can be contaminated with blood, no studies have determined if blood contamination actually represents an infection risk to patients or anesthesia providers. These tests have served as a rapid and inexpensive indicator system that potential contamination may exist.

The proximity of the oropharynx and multiple body fluids to anesthesia equipment poses the potential for cross-infection. Maslyk, Nafziger, Burns, & Bowers[8] conducted a study to determine the amount of microbial growth that develops on the anesthesia machine after a full days use in the OR. Many organisms were shown to survive on the tabletops such as coagulase-negative Staphylococcus, Bacillus, alpha Streptococcus, Acinetobacter, Staphylococcus aurous, and gram-negative rods. Some of these are known pathogenic organisms that can cause respiratory infections, especially in patients with compromised conditions.[9]

Although studies advocate sterilization of laryngoscope blades following their use, this may not occur at all times. Foweraker[35] noted that four pediatric patients had developed serious *Pseudomonas aeruginosa* infections, in which one of the children died from nosocomial pneumonia and septicemia. After a thorough investigation of the environment, they concluded that the probable source of infection came from a single laryngoscope blade that was used on each child. They noted that the blade had dried secretions around the bulb and on the blade and when cultured, a moderate amount of *Pseudomonas aeruginosa* of the same phage type isolated from the blood culture of the child who had died. He concluded that a breach in the cleaning and disinfection process had occurred.[35]

Wenzel and Edmond[36] acknowledged that instruments themselves are sources of pulmonary infections with gram-negative organisms such as *Pseudomonas aeruginosa* or Serratia marcescens, pathogens reflecting an inanimate environmental reservoir. They concluded that if 1% to 5% of all bronchoscopic procedures are performed on patients with TB, and if each is followed by a second procedure with the same scope, 460-2300 patients might become exposed to the virulent pathogen each year if only 10% of the scopes are contaminated. They suggested that the major issue at is identifying when bronchoscopes have been cleaned and disinfected inadequately after use. Cleansing the instrument prior to immersion into glutaraldehyde was found to be a critical step in ensuring that the instruments are effectively disinfected.

Perhaps the most compelling reason for re-evaluating the cleaning, disinfection, and sterilization techniques of airway management equipment comes from the report of outbreaks of *Mycobacterium tuberculosis* infection following bronchoscopic procedures. Agerton et al[37] were concerned with nosocomial transmission of multidrug-resistant tuberculosis (MDR TB) after eight patients with MDR TB were identified in South Carolina in 1995. All were resistant to 7 drugs and had matching DNA fingerprints. Community links were identified for five patients. However, no links were identified for the other three except being hospitalized at the same community hospital and each had received a bronchoscopic procedure after one was performed on a patient with active MDR TB. Investigators concluded that inadequate cleaning and disinfection of the bronchoscope following each procedure led to cross-infection in these patients.

Gadalla and Fong[38] devised a clean way of performing an anesthesia induction to improve infection control in the operating room. First the anesthetist puts on two pairs of clean gloves, induction is carried out, and then as soon as endotracheal tube placement is completed, the blade of the laryngoscope is held in the gloved hand and one outer glove is peeled off the hand and inverted over the dirty laryngoscope blade. The other glove is also removed. The anesthetist then has on a clean pair of gloves. This technique ensures that the used laryngoscope blade never comes into contact with other equipment.

Tobin et al[39] developed a cost effective way to decrease the risk of laryngoscope handle contamination. Small plastic bags available from GEM Medical Industries INC. for $0.03 per unit can be placed over the laryngoscope handle and secured with tape. After the completion of each case the blade is sent for sterilization and the bag is disposed of, after which a new one is applied.

To help decrease the spread of nosocomial infections, the American Association of Nurse Anesthetists recommends the use of a disposable laryngoscope blade when possible.[40] Single-use airway equipment is designed to be used once and then discarded.[15] There may be concern about the quality of some of these devices because they are manufactured at lower cost to justify their disposal.

Successful tracheal intubation depends on adequate visualization of the larynx, adequate illumination of the larynx, and operator skill. Therefore, anesthetists may be concerned about difficulties in obtaining a view of the glottis with single-use laryngoscope blades. Amour et al[41] conducted a study of 1,072 adult patients undergoing general anesthesia under emergency conditions and requiring rapid sequence induction (RSI). The patients were randomly assigned to either single-use metal or reusable metal laryngoscope blades on a weekly basis. Both groups were similar in their main characteristics and risk factors for difficult intubation. The purpose of the study was to determine the rate of failed intubations. The researchers found the rate of failed intubation was significantly decreased with the single-use metal blades at the first attempt compared with reusable blades (2.8% versus 5.4%, $P<0.05$).

However, single-use blades are manufactured with different designs and materials. The plastic single use laryngoscope blade is reported to be less efficient than a metal reusable blade during a rapid sequence induction of anesthesia.[10] This idea has been corroborated by Jabre et al[13] and Galinski et al.[4] This is in part due to the increase in flexibility that is seen with disposable plastic laryngoscope blades.[12] In routine use, the single-use laryngoscope blade appears to be an efficient device but it has been recommended to have conventional reusable laryngoscope blades reserved for difficult intubations.[14]

A comparison of three laryngoscopes including a standard stainless steel Macintosh 3 blade, the same blade with a disposable cover applied and a disposable Macintosh 3 blade in reference to the ease of intubation using a high-fidelity human patient simulator was conducted.[11] The high fidelity human patient simulator can provide a range of intubation conditions from easy to impossible. Anesthetist with similar experience performed laryngoscopy with each of the three laryngoscopes in both easy and difficult simulator intubation settings. For the easy setting, 34% ($P=0.001$) of anesthetists graded laryngoscopy more difficult with the covered laryngoscope and 22% ($P=0.008$) with the disposable laryngoscope considered laryngoscopy more difficult than with the standard reusable metal laryngoscope. Sixty-nine percent ($P<0.001$) of anesthetists found laryngoscopy more difficult with the disposable laryngoscope blade in the difficult simulator setting. Although a high-fidelity patient simulator allows for standardized, reproducible intubating conditions there is debate as to whether it is an adequately validated tool for assessment of anesthetists. "However, despite reservations about induced harm and the unknown risk of an iatrogenic disease, most clinicians would want single-use devices used on themselves and their family if they were patients."[15]

Successful intubation requires appropriate skill but also depends heavily on access to good equipment. A similar study determined that there is better user satisfaction with metal disposable blades ($p<0.001$) and that there is greater force needed to intubate with the disposable laryngoscope blade.[16] There was a statistically significant ($p<0.01$) increase in illumination when a disposable blade was used.[17]

Summary

Manipulation of a patient's airway, as with intubation procedures may often be bloody. Several studies suggest the current procedures for cleaning, disinfecting, sterilization and handling of reusable laryngoscope blades and handles may be ineffective, or that there may be poor compliance with established protocols. The devastating spread of communicable diseases over the past few decades has resulted in the development of guidelines to be used to protect patients as well as health care workers from potential exposure to blood-borne pathogens. The need for continued vigilance and evaluation of airway management equipment is evident. Although the concept of disposable laryngoscope blades makes sense, several previously published studies reported less user satisfaction than with the reusable laryngoscope blades. The main advantages of using a disposable laryngoscope blade involved infection control, cost and bright fiberoptic lighting. In the end the decision to use a disposable laryngoscope blade over a reusable laryngoscope blade will come down to the provider of accrediting and regulatory bodies, institutions and individual preference.

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Appendix C: Questionnaire

Date_____

Emerging Evidence in Infection Control Effecting Change
Questionnaire

1. Gender
   a. Male
   b. Female

2. Which best describes your client base
   a. Adults
   b. Children
   c. Obstetrical

3. Are you aware of Single –use laryngoscope blades?
   a. Yes
   b. No

4. Have you used Single –use laryngoscope blade?
   a. Yes
   b. No

5. Which best describes the amount of time you use the single-use laryngoscope blade:
   a. Always
   b. 75%
   c. 50%
   d. 25%
   e. Never

6. If you have used the Single-use laryngoscope blade, did you find it easy to use?
   a. Yes
   b. No
   c. Not Applicable

7. If you routinely use the Single-use laryngoscope blade, how many times would you say that you had to change to a traditional multi-use laryngoscope blade?
   a. Never
   b. <25% of the time
   c. <50% of the time
   d. <75% of the time
   e. Not Applicable

8. What best describes your reason for NOT using a Single-use Laryngoscope blade.
   a. Not available to you
   b. Expense
   c. Performance
   d. Other

9. Which type of Single-use laryngoscope blade is available to you?
   a. Plastic
   b. Metal
   c. Both
   d. Not applicable

10. How long have you been in anesthesia practice
    a. <1 year
    b. Between 1 and 5 years
    c. Between 5 and 10 years
    d. >10 years

11. Please list any complications you have encountered in using a single-use laryngoscope blade.
    a. _____
    b. _____
    c. None

Appendix D: Data Collection Sheet

	Question1	Question2	Question3	Question4	Question5	Question6	Question7	Question8	Question9	Question10	Question11
P1											
P2											
P3											
P4											
P5											
P6											
P7											
P8											
P9											
P10											
P11											
P12											

Appendix E: Disposable Laryngoscope Blade Inventory Sheet

ANESTHESIA - DOCUMENTATION OF SURGICAL CHARGES & ANESTHESIA MEDICATIONS ADMINISTERED

DESCRIPTION	CODE	Q/U	DESCRIPTION	CODE	Q/U	DESCRIPTION	CODE	Q/U
ANESTHESIA:			**GENERAL ITEMS (Continued)**			**PHARMACY**		
Blood Warmer	44038		Support-Arterial	30992		IV-Mini Bag	20005	
Circuit-Anesthesia-Adult	30075		Swan-7.5 VIP	31216		IV-Solution	40509	
Circuit-Anesthesia-Ped.	30076		Swan-7 FR	31232		D5LR 500mL	17397	
Mask-Disp.	30140		Swan-Pace Port	31211		LR 1000mL	17424	
ENDOTRACH TUBES			Swan-Pace Port Probe	31212		NS 250mL	20013	
Adult-Pediatric	30070		Suction Catheter	31144		NS 0.45% 1000mL	17309	
Epidural Catheter	32077		Suction Bottle	32045		NS 0.9% 100mL	17305	
Epidural Tray	30155		Suction Tubing	30793		NS 0.9% 500mL	17304	
Esoph. Stethoscope	30149		Triple Lumen Cath.	30586		**OTHER CHARGES**		
Laryngo Blade/Disp.	44653		**IV ITEMS**					
LTA Kit	30069		Buretrol	20164				
Nasal Airway	30072		Extension Tubing	25014				
Nasal Cannula	30074		IV Tubing / 10 Drop	20160				
Oral Airway	30073		IV Tubing / 60 Drop	20161				
Spinal Tray	67000		IV Tubing / 96 cm	25105				
GENERAL ITEMS			Jelco Catheter	36015				
CVC Cath. Kit-16 Ga.	31223		Needle Lock	20159				
CVP Manometer	31966		Y-Blood Set	20163				
IV Plug	25038		**MONITORS**					
Monitor Kit-Adult	30006		General Anesth. 1st Hour	61008				
Monitor Kit-NICU	30351		Additional 0.5 Hours	61010				
Perc Set 8.5	31226		M.A.C.	40190				
Radial Cath. Kit	30601		**EQUIPMENT**					
			Thermocap	39971				
			K-Pad-Aqua	30825				

Anesthesiologist Signature: Date: Time:

R.N. Signature: Date: Time:

ANES

PGH-701-00881 (REV 01/20/2010)

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VITA

Melissa Machan was born and raised in Jacksonville, Florida. She graduated from the Florida Community College School of Nursing in 1999. She then received her Bachelor of Science in Nursing degree at the University of North Florida in 2000. She worked in the intensive care unit for three years before continuing her education and receiving her Masters of Science in Anesthesiology Nursing at the Florida International University in 2003. She is credentialed as a Certified Registered Nurse Anesthetist, licensed in Florida as an Advanced Registered Nurse Practitioner, and is currently employed at Plantation General Hospital in Plantation, Florida as a staff anesthetist. She authored an article entitled, “Infection Control Practices of Laryngoscope Blades: A Review of the Literature”, which was accepted for publication in August of 2012 in the American Association of Nurse Anesthetists Journal.