

STETHOSCOPES AS A SOURCE OF HOSPITAL-ACQUIRED MRSA

by

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Departmental Honors Thesis
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Acknowledgements

Many thanks for the support of my family, friends, and committee members. To my family, thank you for your emotional support and encouragement. To my husband, thank you for your ever calming presence. I thank Susannah, for her wise admonishment and knowing advice.

Many, many, many thanks to each of my committee members, who were instrumental in the completion of this project. I thank Dr. Wertenberger for her guidance early on in the project. I thank Dr. Schreeder for her wise advice and especially for trekking around the hospital with me. Thanks to Professor Bell for her support, enthusiasm for the project, and the hours spent in the lab. Thanks to Dr. Wheatley for her view point, guidance, and editorial eye. I am so grateful to Dr. Secrest for her guidance and for her willingness and energy to take on this project. Thanks to each of you for making this a great experience.

This research was supported in part by a grant from the University Provost Student Research Award.

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TABLE OF CONTENTS

Abstract.....	1
Problem	
Introduction.....	2
Purpose of the Project.....	5
Conceptual Framework.....	5
Objectives of the Research.....	5
Hypothesis.....	6
Review of the Literature	
Documentation.....	7
Hospital Acquired Infections.....	7
Methicillin Resistant <i>Staphylococcus aureus</i>	9
Stethoscopes as Fomites.....	12
Stethoscope Disinfection Practices.....	13
Summary.....	15
Methodology	
Instruments.....	17
Sample.....	17
Protection of Human Subjects.....	18
Procedure.....	18
Results of Findings	
Analysis.....	21
Summary.....	22
Discussion and Implications	
Limitations.....	24
Implications.....	26
References.....	28
Appendices	
Appendix A.....	34
Appendix B.....	35
Appendix C.....	36
Appendix D.....	37
Appendix E.....	38
Appendix F.....	41

Appendix G.....	42
Appendix H.....	43
Appendix I.....	44

ABSTRACT

Because of frequent contact with patients, stethoscopes are a potential vector for methicillin-resistant *Staphylococcus aureus* (MRSA) which may lead to hospital-acquired infections. The purpose of this project was to determine the presence of MRSA on the diaphragms of personal and unit stethoscopes within a hospital setting before and after cleaning with 70% isopropyl alcohol prep pads. The sample consisted of 141 personal and unit stethoscopes in adult medical-surgical and intensive care units of a large university hospital in the Southeast. Each stethoscope was cultured twice: once before cleaning and once after cleaning. Cultures were obtained using pre-packaged sterile swabs and inoculated on a selective medium for MRSA. Although some bacterial growth was noted on the cultures, no MRSA colonies were detected. Six un-identified bacterial colonies were noted in the pre-cleaning group. The post-cleaning group had no bacterial growth. There was not enough data to statistically support that that isopropyl alcohol is effective in decreasing bacterial counts. However, these findings suggest that current disinfection guidelines are effective in preventing MRSA colonization on stethoscopes in this setting. It also supports previous research that regular cleaning with isopropyl alcohol pads is effective in decreasing general bacterial counts on stethoscope diaphragms.

CHAPTER 1

Introduction

Nosocomial infections, also termed hospital-acquired infections (HAIs), are those infections that are acquired while within the healthcare setting. HAIs are caused by bacteria, viruses, fungi, or parasites that may be present in the patient or found in the healthcare environment. In the United States alone, the Center for Disease Control and Prevention (CDC) (2010) estimated that HAIs account for 1.7 million infections and 99,000 deaths each year. The direct medical costs of HAIs were estimated to be \$4.5 billion dollars annually (Scott, 2009). It has been suggested that of the 5-10% of patients admitted to acute health care facilities who acquired HAIs, approximately 20% could have been prevented through strict adherence to infection control guidelines (Harbarth et al., 2003).

The CDC (2008) recommended strict hand washing and cleaning of the health care environment as measures effective in reducing HAIs. Hand washing has been cited as the most effective infection control method and the rates of hand washing have improved; this has correlated with a focused approach by hospital infection control committees to meet Joint Commission (2010) regulatory mandates regarding hand washing. Additionally, the Centers for Medicare and Medicaid (CMS) have informed agencies of its refusal to pay for HAIs (Deficit Reduction Act of 2005, Section 5001(c)).

As an extension of the hand, nurses, physicians, and others use their own stethoscopes for assessment of patients, going from patient to patient. Most nursing

units also have “unit” stethoscopes that are used communally by many different healthcare workers. The stethoscope is a tool healthcare providers use daily in the assessment of patients. Thus in a single day, the stethoscope may come in direct contact with multiple patients, clothing, and the environment. Following assessment, the stethoscope is typically placed in a laboratory coat pocket, draped around the neck, or suspended from a medication cart. The stethoscope is then taken to the next patient assessment without cleaning.

Unlike hands, the cleaning of stethoscopes has received less attention. The Healthcare Infection Control Practices Advisory Committee recommended “at minimum, noncritical patient-care devices are disinfected when visibly soiled and on a regular basis (such as after use on each patient or once daily or once weekly)” (CDC, 2008, p. 84). As evident from the ambiguity of this recommendation, there is no consensus regarding which frequency of cleaning is most efficacious.

Stethoscopes are known to harbor potentially harmful bacteria. As early as 1972, stethoscopes were identified as a fomite on which bacteria are capable of surviving for various amounts of time (Gerken et al., 1972). On inanimate objects, *Escherichia coli* has reported to live 1.5 hours to 16 months; *Staphylococcus aureus* (including the resistant form Methicillin Resistant *Staphylococcus aureus* [MRSA]) 17 days to 7 months; and *Clostridium difficile*, 5 months on inanimate objects (Kramer, Schwebke, & Kampf, 2006). Not only are these organisms able to survive on the surface of inanimate objects, but it has also been reported that bacteria may be transferred to human skin from surfaces (Marinella, Pearson, & Chenoweth, 1997).

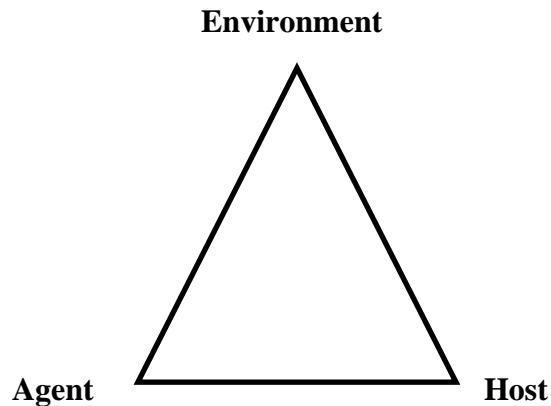
The possibility that infectious organisms, particularly MRSA, can be transmitted via the stethoscope and contribute to HAIs is important to the nursing and medical community. The proportion of HAIs related to MRSA in intensive care units has increased from 2% in 1974 to 64% in 2004 (CDC, 2007). Furthermore, of the 94,000 cases of invasive MRSA infections that occur on average each year, 86% are healthcare-associated and lead to 19,000 deaths annually (Klevens et al., 2007). Cleaning practices for assessment tools, such as stethoscopes, are erratic, and potentially pathogenic bacteria have been found on the diaphragms of stethoscopes of physicians and nurses (Whittington, Whitlow, Hewson, Thomas, & Brett, 2009). Although the role of stethoscopes in the transmission of pathogens has been studied (Gerken et al., 1972; Marinella et al., 1997; Guinto, Bottone, Raffalli, Montecalvo, & Wormser, 2002), few studies have discussed the role of stethoscopes in the transmission of MRSA (Merlin et al., 2009).

Purpose of the Project

The purpose of the study was to compare MRSA colonization on the diaphragm of stethoscopes before and after cleaning with isopropyl alcohol at a large teaching hospital.

Conceptual Framework

The framework underlying this research project is the Epidemiological Triangle (CDC, 2009). Figure 1. displays a model of this framework.



The epidemiological triangle is an organized way to view the relationships between host, environment, and agent. According to this framework, the development of disease is “dependent upon the extent of the host’s exposure to an agent, the strength or virulence of the agent, and the host’s genetic or immunological susceptibility” as well as “the environmental conditions existing at the time of exposure” (Nies & McEwen, 2007, p. 51). By analyzing these three elements, it is possible to evaluate the vulnerabilities of a situation that makes a patient prone to disease. The epidemiological triangle has been used to describe the relationship of these three variables in previous studies, including those researching infection, cancers, and mental illnesses. The framework has more specifically been used in research specifically examining MRSA transmission and hospital infections (Campbell, Bryant, Stover, & Marshall, 2003; Mollema, Richardus, Behrendt et al., 2009). With simple links between agent, host, and environment, the relationships between HAIs and MRSA can be readily explained using the epidemiological triangle (Nies et al., 2007).

The concepts included in the framework are the following:

1. Environment. External conditions or surroundings, which can change according to proximity, circulation, and temperature.
2. Agent. A factor, such as bacteria, whose presence is essential for the occurrence of a disease, which can vary in number and virulence.
3. Host. A person or other living organism that can be infected by an infectious agent under natural conditions. The person can become more or less susceptible based upon his or her immunological status.
4. Time. Center of the Triangle. The incubation period of the agent; the time between host infection and disease symptoms, and the duration of the illness or condition.

Objectives of the Research

1. To determine the presence of MRSA on the diaphragm of clinicians' stethoscopes.
2. To determine if the disinfectant isopropyl alcohol is useful in decreasing the number of colonies of MRSA on the diaphragm of stethoscopes.

Hypothesis

Disinfection with isopropyl alcohol wipes will decrease the number of MRSA colonies found on the diaphragms of clinicians' stethoscopes.

CHAPTER 2

Review of the Literature

Documentation

The main questions posed when beginning the background research on this topic included: Is the stethoscope a common vector of infection? If so, is the role modifiable through intervention with bactericidal cleaning measures? Beginning research on this topic included web searches with combinations of key words: stethoscopes as fomites, stethoscope disinfection, MRSA, hospital-acquired infections (HAIs) and/or nosocomial infections. Article databases searched included: CINAHL, PubMed, EbscoHost, and OVID.

Review of the Literature

A review of the literature was conducted to provide a frame of reference for the current study. This literature review describes the body of knowledge regarding MRSA (the agent), the possible role stethoscopes (the environment) play in the transmission of infectious organisms (including MRSA) and the development of HAIs among patients (the host), and current stethoscope disinfection practices in healthcare.

Hospital Acquired Infections

Historical Background

Hospital-acquired infections (HAIs) are those infections that are acquired while within the healthcare setting. In the United States alone, HAIs account for two million infections, 90,000 deaths, and \$4.5 billion dollars in healthcare costs annually

(CDC, 2010). As with any infection, HAIs are caused by bacteria, viruses, fungi, or parasites. Specifically, HAIs develop while hospitalized and are caused by agents that may be present in the patient's body or found in the healthcare environment.

Although patients who are immunocompromised are at increased risk of acquiring an HAI, anyone who is a patient in a hospital is at risk for HAI (CDC, 2008).

Current Rates

The CDC (2007) reports the most common types of HAIs are urinary tract infections (32%), surgical site infections (22%), pneumonias (15%), and bloodstream infections (14%). HA-urinary tract infections usually originate from bacteria that normally reside in the patient's intestine. Patients at increased risk include those with indwelling urinary catheters, long-stay elderly male patients, and those undergoing urological procedures (Kalsi, Arya, Wilson, & Mundy, 2003). Most surgical site infections can be attributed to patients' risk factors, rather than inadequate surgical care (Barie, 2003). These include previously contaminated operation sites, the patient's health status before operations, and the physical environment where the surgery is performed.

HA-pneumonia includes ventilator-associated pneumonia, postoperative pneumonia, and any other form of pneumonia that develops in hospitalized patients at least 48 hours after hospital admission. Common pathogens cited in HA-pneumonia include *Staphylococcus aureus* (*S. aureus*) (including MRSA), *Streptococcus pneumoniae*, and *Haemophilus influenzae* (Bartlett, 2008). The most serious risk factor is endotracheal intubation with mechanical ventilation. In a surveillance study

of nosocomial bloodstream infections, the most common infection causing organisms are coagulase-negative staphylococci (31%), *S. aureus* (20%), and *enterococci* and *Candida* (both 9%) (Wisplinghoff et al., 2003). *S. aureus* isolates with methicillin resistance as the cause of HA-pneumonia increased from 22% in 1995 to 57% in 2001 (Wisplinghoff et al., 2003).

Prevention Guidelines

Of the 5-10% of patients admitted to acute health care facilities who acquired HAIs, approximately 20% could have been prevented through strict adherence to infection control guidelines (Harbarth et al., 2003). These include following standard precautions, and suggested droplet, contact, and airborne infection isolation precautions.

Methicillin Resistant *Staphylococcus aureus*

Epidemiological Background

Multi-drug resistant *Staphylococcus aureus* (*S. aureus*) has been an international problem since the 1950s (Fluit & Schmitz, 2003). MRSA most commonly causes skin infections, but can also cause much more serious, even fatal, infections such as pneumonia (CDC, 2010). The resistance of *S. aureus* to penicillin occurred soon after the drug's development in the era of World War II. This situation required a drug that could be stable in the presence of staphylococcal penicillinase, which rendered the drug useless against the organism. In 1960, methicillin was successful in treating *S. aureus*, however, by 1961 Jevons had reported resistance (Fluit & Schmitz, 2003). Later in the 1960s, resistance to erythromycin and

tetracycline were also documented (Fluit & Schmitz, 2003). Currently, MRSA is typically resistant to aminoglycosides, clindamycin, fluoroquinolones, and macrolides. Resistance to vancomycin has now also been detected (Fluit & Schmitz, 2003). The emergence of resistance has been attributed mainly to overuse and misuse of antibiotics. MRSA was once thought to be only a “hospital” problem, but has been further delineated into community-acquired (CA-MRSA) and hospital acquired (HA-MRSA).

Current treatments for MRSA infections are dependent on the site. Culture and sensitivity testing is used as a guide for drug choice. Common pharmaceutical treatments of choice for MRSA infection are combinations of trimethoprim-sulfamethoxazole, clindamycin, tetracyclines, and linezolid (Gorwitz et al., 2006).

Populations at Increased Risk

The biggest risk factor for MRSA infection is open or broken skin, although MRSA infections can occur on intact skin (CDC, 2010). Other risk factors for hospital-acquired MRSA include hospitalization (current or recent), residence in a long-term care facility, invasive procedures such as surgery, and recent or long-term antibiotic use (Zeller, 2007).

Current Rates

Overall, the rates of HA-MRSA have increased since its emergence in the mid 20th Century. According to Klevens et al. (2006), 2% of *S. aureus* infections were identified as MRSA in 1974 compared to 64% of cases in 2004. However, there is indication that the overall increasing trend is slowing. For instance, over the 4-year

period from 2005 to 2008, the incidence of HA-MRSA decreased 9.4% per year (Kallen et al., 2010). Similarly, the incidence of central line-associated bloodstream infections related to MRSA has decreased 50-70% between 2001 and 2007 (Burton et al., 2010). This may be related to improved environmental controls, rigorous treatments, national campaigns, and earlier diagnoses.

Prevention Guidelines

Prevention and control of MRSA in the healthcare setting is based mainly upon standard precautions and basic infection control principles. According to the CDC, the main mode of transmission is via the hands, which may be contaminated by contact with colonized patients, personnel, items, or environmental surfaces (2007).

Standard precautions include the following: hand hygiene before and after all patient contact or when visibly dirty, wearing gloves and other personal protective equipment (gowns, mask, face shield) when contact with blood or body fluids could likely occur (CDC, 2007). It also outlines appropriate use of patient care equipment and laundry, namely that frequently touched surfaces are cleaned and disinfected regularly. It is recommended that those diagnosed with a MRSA infection be placed on contact precautions, which include the following: isolating the patient, wearing gloves whenever in close proximity to patient, and gowning upon entry to the patient's room. Further recommendations include that patient-care equipment is disposable or dedicated to the patient, transport is limited, and the room is cleaned and disinfected at least daily.

Stethoscopes as Fomites

Historical Background

Data have supported the idea that stethoscopes can act as fomites for over thirty years (e.g., Gerken et al, 1972; Breathnach et al., 1992; Whittington et al., 2009). The majority of studies have focused broadly on the stethoscopes of nurses and physicians in the hospital setting. In one of the first studies, the stethoscopes of medical interns, residents, faculty, and nurses (N=50) were cultured. Thirteen stethoscopes (26%) were reported as contaminated with a potential pathogen, meaning bacterial colonies that were not common skin flora (Mangi & Andriole, 1972). The same year, bacterial contamination of stethoscopes was reported again (Gerken et al., 1972). These findings resound throughout each decade. Physician stethoscopes (N=29) were cultured and 26 (89%) yielded potentially pathogenic bacteria (Breathnach et al., 1992). In a study limited to one ICU, ear buds and the diaphragms of stethoscopes were examined. Out of the 24 stethoscopes tested, two diaphragms (8.3%) contained pathogens (Whittington et al., 2009). The results show that bacterial colonization with potential pathogens is a common finding.

Common Bacteria Cultured from Stethoscopes

Expected bacterial growths on stethoscopes include common skin flora organisms *Staphylococcus* (non-pathogenic form) and *Corynebacterium*. There is little concern for the transmission of normal skin flora between individuals. However, stethoscopes may become contaminated with pathogenic bacteria. Although MRSA is a commonly cited organism on stethoscopes, other pathogenic bacteria have been

reported, such as *Escherichia coli*, *Enterobacter*, *Klebsiella* (Mangi & Andriole, 1972) and *Micrococcus luteus* (Marinella et al., 1997).

Multiple studies have reported MRSA colonization on stethoscopes. In one, 200 stethoscopes of physicians, nurses, and hospital personnel were tested among four hospitals and outpatient clinics. Of those cultured (N=200), *S. aureus* was noted on 17 (8.5%), with four (2%) of those being resistant to methicillin (Smith et al., 1996). Similarly, MRSA was isolated in a study conducted at a single community-based hospital and a satellite family health center (Schroeder et al., 2009). Three stethoscopes (3.2%) of the 93 cultured (N=93) reportedly carried MRSA. Of 50 stethoscopes (N=50) of emergency medical service providers (EMS) in one emergency department in a large hospital, 16 (3.2%) had MRSA colonization (Merlin et al., 2009). In all these studies, recommendations included frequent cleaning of the stethoscope.

Pathogen Transmission from Stethoscope

Transfer of a pathogen from a stethoscope to human skin is necessary for infection to be possible. Transmission of *Micrococcus luteus* on a stethoscope diaphragm to human skin was reported on an intentionally contaminated the diaphragm (Marinella et al., 1997). Because of the favorable conditions for MRSA growth on skin, it is believed MRSA would follow the same pattern of transmission. As with all other contaminated surfaces, contact with a stethoscope harboring MRSA can allow the spread of bacteria to a patients' skin (CDC, 2010).

Stethoscope Disinfection Practices

Current Practices

Frequency of Cleaning. In self-reports of frequency of cleaning, the practice of stethoscope cleaning is infrequent in the majority of settings and among all healthcare providers. Of 16 (32%) EMS professionals (N=50) had no recollection of when their stethoscopes had last been cleaned (Merlin et al., 2009). The median number of days between cleaning was one to seven days. In addition, the stethoscopes that had not been cleaned recently were at greater risk for having MRSA colonization. Similar results were found among other groups. Of 150 health care personnel questioned in an emergency department of a large community teaching hospital, 48% cleaned it daily or weekly, while 7% reported never cleaning their stethoscopes (Jones et al., 2005). Comparatively, in an ICU in the United Kingdom, nurses reported cleaning after every use (Whittington et al., 2009). It is difficult to determine the accuracy of these studies because of their reliance on self-reporting, which is at best an inconsistently accurate assessment tool (Bhandari & Wagner, 2004). This inconsistency is in spite of many recommendations that stethoscopes be cleaned with the same frequency as the hand (Lecar et al., 2009).

Preferred Cleaning Methods. Wiping the stethoscope with saturated alcohol swabs has traditionally been the cleaning method of choice. The effectiveness of alcohol swabs, non-ionic detergent, and antiseptic soap was compared. Alcohol was reportedly the most effective, decreasing bacterial counts on the diaphragm by 94% as compared to antiseptic soap, which was reported to decrease counts by 74% (Jones et al., 1995). Similarly, the effectiveness of isopropyl alcohol sodium hypochlorite,

benzalkonium chloride, and soap and water were compared. In addition to being effective at reducing the bacterial load on the diaphragm of stethoscopes, isopropyl alcohol was reported as superior in cleaning the rim area (Marinella et al., 1997). One study was designed so that each participant used 62.5% ethyl alcohol-based foam to cleanse their hands while simultaneously rubbing the head of the stethoscope. Significant reduction of bacterial colonies on the stethoscope after simultaneous cleansing on 92 stethoscopes was reported (Schroeder et al., 2009). Researchers concluded that the main benefit of this disinfection method is no extra cost (for wipes) and no extra time needed. Some of the shortcomings of alcohol sanitizers include that they do not kill sporulating organisms such as *Clostridium difficile* (Schroeder et al., 2009), and routine use of alcohol based products may dry out the rubber seals of stethoscope diaphragms (Jones et al., 1995). Antimicrobial diaphragm covers have been introduced as a possible solution, but stethoscopes with these covers have been associated with higher numbers of colony counts (Wood, Lund, & Stevenson, 2007).

Summary

Common findings are reiterated throughout the literature. Colonization of stethoscopes by potential pathogens has been found (these include the various strains of *staphylococci*, including MRSA). Isopropyl alcohol has been shown to be an effective disinfectant for the diaphragm of stethoscopes (Lecar, Cropp, McCord, & Haller, 2009), and cleaning of clinician's stethoscopes is described as "infrequent" in self-reports (Merlin et al., 2009). This is in spite of recommendations that healthcare

workers clean their stethoscopes frequently (Schroeder et al., 2009). The common weaknesses of previous studies include small sample sizes (≤ 50 stethoscopes) and the location of the stethoscopes (such as limiting the study to one department).

CHAPTER 3

Methodology

The methodology was a pre-test/post-test design, with each stethoscope serving as its own control. This design was chosen because it would demonstrate the effectiveness of cleaning on the bacterial counts of each stethoscope. The sample was convenience of clinician and unit stethoscopes from adult medical/surgical units and intensive care units (ICUs) in a large university hospital in the Southeast United States. All available stethoscopes in these units were included, which totaled 141 stethoscopes (242 total cultures with pre- and post-test). Clinician stethoscopes of physicians, nurses, and assistive personnel on those units and the unit stethoscopes were included in the study.

Instruments

The instruments used include sterile isopropyl alcohol 70% pads, sterile culture transport system with media, and CHROMagar, a selective medium for MRSA. The validity of this medium as a rapid and sensitive selective surveillance medium for MRSA is established (Flayhart et al., 2005). CHROMagar has been reported as superior to the medium TSA II for recovery and identification and comparable to all other methods of sampling, with the added benefit of being rapid and inexpensive (Flayhart et al., 2005). Based on the supported findings in this study and in other literature, CHROMagar was chosen as the medium for the study.

Sample

The accessible population included the stethoscopes of nurses, physicians,

respiratory specialists, and unit stethoscopes. The clinicians were not informed that the researcher would be assessing stethoscopes beforehand. The researcher entered the floor unannounced and then began collecting stethoscopes individually. Seventeen units, including ICUs and medical-surgical units were included. On average, eight stethoscopes were assessed per unit. Stethoscopes in these areas that were omitted included those dedicated to patients with contact precautions and any that were not visible and not volunteered to be studied.

Protection of Human Subjects

Approval was obtained from the University as well as from the medical center institutional review boards (Appendix A, B). Clinicians were assured anonymity and consent was inferred by allowing their stethoscopes to be swabbed. An information sheet detailing the procedure was available (see appendix C) and an opportunity to decline to participate was given. The samples taken from the stethoscopes were labeled with a numbered code and the names of clinicians were not identified in any way. Only the role of the clinician was recorded, such as nurse or physician. Participation posed no risk to the clinicians or patients. On average, the procedure required the individual to be without a stethoscope for five to ten minutes.

Procedure

The researcher collected all data. The stethoscopes were placed near the supplies for data collection. The diaphragm of each stethoscope was swabbed with a pre-packaged sterile swab. The sterile swab was placed in the sterile transport medium that accompanies that package. The tube was then coded and labeled as pre-

cleaning, the stethoscope's current location, and the role of the owner (Appendix D). The diaphragm was then cleaned with a sterile alcohol prep pad (70% isopropyl alcohol) with a circular motion. The diaphragm was allowed to dry and then swabbed again with a second sterile swab. The tube carrying the post-cleaning swab was then labeled. The tubes were then placed upright in a box provided by the researcher. This was repeated 141 times over the course of two days. Each day, after four hours of collection, cultures were then taken to a local university microbiology lab, where the medium was kept. The medium was received the day before data collection began and was kept in the dark at room temperature before inoculation. Each plate of media was divided into four or five sections so that more than one culture could be tested per plate. Each section was labeled and streaked with a single corresponding culture. The transported cultures were plated directly onto the medium by streaking the swab onto the medium. The cultures were incubated in the dark at 37° Celsius for 72 hours. The cultures were assessed for growth at 24, 48, and 72 hours as recommended by the manufacturer of the medium (Appendix E).

Control measures to promote unbiased results included swabbing only the diaphragm of the stethoscope without removing the ring, excluding stethoscopes dedicated to patients with the diagnosis of MRSA, and using only medical-surgical and ICU units. In addition, limiting the study to only MRSA, using pre-packaged alcohol prep pads, and studying on floors with only adult patients are further controls. One plate of BBL CHROMagar was divided into quarters and then inoculated with MRSA, methicillin-susceptible *Staphylococcus aureus* (MSSA), *Streptococcus*, and

Staphylococcus epidermis (a common organism found on skin) as a comparison plate (Appendix F).

The data were analyzed using descriptive statistics. The frequency of MRSA found before and after cleaning was noted as well as bacterial counts noted on the medium. The location and job position of the individuals with the stethoscope was noted and compared. A paired t-test for comparison of bacterial counts before and after disinfection practices was completed, although inappropriately used in this instance.

CHAPTER 4

Results

The sample set consisted of a total of 141 stethoscopes (N = 141). This included stethoscopes from 12 (8.5%) physicians, 88 (62%) nurses, six (4.25%) respiratory therapists, and 35 (25%) unit stethoscopes; 48% of stethoscopes were from ICUs and 52% of stethoscopes were from medical-surgical units. The total number of cultures was 282 (one pre-cleaning sample and one post-cleaning sample from each stethoscope). The stethoscopes of physician and respiratory therapists may travel from unit to unit with the clinician, while the stethoscopes of nurses and the units remain in that area.

After 72 hours of observation, no MRSA growth was noted in any of the 282 cultures. Unidentified bacterial growth was noted after 24 hours of observation on two plates (1.4%). At 72 hours of observation, unidentified growth was noted on four plates (2.8%). This is notable because this selective medium is intended to inhibit the growth of many organisms. Three of the six cultures that grew bacterial colonies were from unit stethoscopes, two were from the stethoscopes of nurses, and the final growth was taken from the stethoscope of a physician. Proportionally more unit stethoscopes and physician stethoscopes showed bacterial colonization (8.5% of unit stethoscopes and 8.3% percent of physicians' stethoscopes versus 2.2% of nurses' stethoscopes). See Table 1.

Role	N	Pre-Cleaning samples developing colonies	Post-Cleaning samples developing colonies
Nurse	88	2 (2.2%)	0
Unit	35	3 (8.5%)	0
Physician	12	1 (8.3%)	0
Respiratory Therapy	6	0	0

Although no MRSA was identified on the samples, there was a difference between the bacterial colony counts of pre-cleaned cultures and post-cleaned cultures ($t= 2.494$; $df= 140$; $p= 0.014$). The number of stethoscopes with bacterial colonies is too small to compare with any statistical significance.

See Table 2.

LOCATION	N	Pre-cleaning samples which developed colonies	Post-cleaning samples which developed colonies
Medical-Surgical Unit	73	3	0
ICU	68	3	0

Summary

Agent. Although no MRSA growth was noted on the cultures of the

stethoscopes, a small number ($n = 6$) of cultures revealed bacterial growth (Appendix G). These organisms may or may not be pathogenic bacteria. These findings suggest that MRSA growth is not significant on the stethoscopes found in this sample.

Environment. Furthermore, 4% (6/141 stethoscopes) of stethoscopes were reported to harbor organisms. The sample was too small to compare using a t-test.

CHAPTER 5

Discussion and Implications

Because of the prevalence and antimicrobial resistance of MRSA, identifying vectors of infection and a means of disinfection is important. The purpose of the study was to assess the current level of MRSA colonization on the diaphragm of stethoscopes found at a large teaching hospital and to compare bacterial growth before and after disinfection with isopropyl alcohol.

No MRSA was recovered from any of the diaphragms of the stethoscopes studied. This was surprising, because this finding is contrary to previous studies (Merlin et al., 2009; Schroeder et al., 2009). This finding could indicate that the current stethoscope disinfection guidelines set by the CDC *Guideline for Disinfection and Sterilization in Healthcare Facilities 2008* are effective in controlling the growth and spread of MRSA in this hospital. Additionally, the data in this study support the previous findings that alcohol is effective in decreasing the number of bacterial colonies on the diaphragms of stethoscopes (Lecat, Cropp, McCord, & Haller, 2009).

Limitations of the Research

The current study was limited to a convenience sample of stethoscopes in adult medical-surgical and intensive care units in a single large, level-1 trauma hospital in the Southeast United States. The data collection was limited to two weekdays within the same week. Each unit was only visited once during the two days.

Bias was limited by entering the units unannounced and gathering stethoscopes (with permission) for culturing without allowing physicians, nurses, or

other personnel time for cleaning. Furthermore, the same procedure was used for each of the stethoscopes studied. A large sample was available (N=141), which minimizes some of the limitations found in studies with a small sample size. A post hoc power analysis revealed a power of 0.99 for the sample size. During data collection, bias that certain brands of stethoscopes may harbor more bacteria than others was formed. This was minimized by maintaining the same procedure for each stethoscope, despite differences in brands.

Children's hospital and emergency room were not included because the data that support most hospital acquired MRSA occurs in individuals 65 years and older (Klevens et al., 2007). Furthermore, obstetrics and gynecology (OB/GYN), surgery, physicians' offices, and adult emergency were not included. Non-hospitalized patients or well OB/GYN patients have fewer risk factors than patients in the hospital, and have correspondingly lower infection rates (Siegel, Rhinehart, Jackson, & Chiarello, 2006). The researcher did not expand the study to other hospitals because of the limited amount of resources and time available to the researcher. Instead, a large hospital with multiple ICUs and medical-surgical units was chosen. Furthermore, the framework of the study was limited to the epidemiological triangle based on its simplicity and appropriateness for this study.

Because of the limitations, this study may only be generalizable to the adult patient population of ICUs and medical surgical units in a large, teaching hospital in the southeast United States. A number of units that were excluded may have unique environments that could make them prone to MRSA infection (such as community-

acquired MRSA in the emergency department). The study needs to be repeated in another hospital in another region. Those employees who did not work on the two days of data collection were not included. Physicians who were rounding on multiple floors may have been omitted unintentionally as each unit was assessed only once and one at a time. Additionally, the bacterial growth noted on the cultures of the stethoscopes was rejected as MRSA growth but was not identified. Information on the pathogenicity of these organisms is needed.

Implications

The implications of this study are that current guidelines set by the CDC may be effective in preventing MRSA colonization on the diaphragms of stethoscopes in this setting. The CDC (2008) recommends that stethoscopes be cleaned when visibly dirty and regularly. Cleaning the stethoscope before and after every use, as with hands, is a simple, quick way to prevent bacterial colonization on the diaphragm of stethoscopes.

Recommendations for future studies include repeating this study in other hospitals, including those in different regions, other university hospitals, and smaller community hospitals. Replication would give a better picture of the prevalence of MRSA contamination on stethoscopes. More information should also be gathered qualitatively on attitudes about cleaning stethoscopes and current cleaning practices of the healthcare staff. This would shed light on beliefs that are affecting the frequency with which individuals clean their stethoscopes. Additionally, studying which types or brands of stethoscopes are more susceptible for harboring bacteria

could be useful. A possible difference may exist between stethoscopes with a plastic diaphragm versus stethoscopes with a metal diaphragm. This may make one type more prone to bacterial carriage. The effect of regular, multiple cleansing with isopropyl alcohol on the integrity of the diaphragm and its rubber ring is warranted. Furthermore, more studies are needed to assess the link between MRSA colonization on stethoscopes and the effect on patient infection development.

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Bacterial

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APPENDIX A



Institutional Review Board
 Dept. 4903
 510 McCallie Avenue
 Chattanooga, TN 37403-2598
 Phone: 423/425-7100

MEMORANDUM

TO: Anigan, Leo IRB # 10-028
 Dr. Dana Wertenberger

FROM: Lindsay Pardue, Director of Research Integrity
 M. D. Roobyer, IRB Committee Chair

DATE: February 23, 2010

SUBJECT: IRB # 10-028: Evaluation of Stethoscopes as a source of Pathogens Related to Nosocomial Infections

The Institutional Review Board has reviewed and approved your application and assigned you the IRB number listed above. You must include the following approval statement on research materials seen by participants and used in research reports:

The Institutional Review Board of the University of Tennessee at Chattanooga (FWA00004149) has approved this research project # 10-028.

Please remember that you must complete Form C when the project is completed or provide an annual report if the project takes over one year to complete. The IRB Committee will make every effort to remind you prior to your anniversary date; however, it is your responsibility to ensure that this additional step is satisfied.

Please remember to contact the IRB Committee immediately and submit a new project proposal for review if significant changes occur in your research design or in any instruments used in conducting the study. You should also contact the IRB Committee immediately if you encounter any adverse effects during your project that pose a risk to your subjects.

For any additional information, please consult our web page <http://www.uts.edu/irb> or email instrb@utc.edu.

Best wishes for a successful research project.

APPENDIX B

THE UNIVERSITY OF TENNESSEE
Health Science Center



College of Medicine, Chattanooga
Scientific Review Board
960 East Third Street
Suite 102
Chattanooga, TN 37403
Tel: (423) 778-3818 • Fax: (423) 778-4170

May 5, 2010

Abigail Russell
320 High Street, Apt. 7
Chattanooga, Tennessee 37403

RE: Your application dated 4/22/2010 regarding study number 10-036: Evaluation of Stethoscopes as a Source of Nosocomial Infections (N/A)

Dear Ms. Russell:

The Chairman of the UT-College of Medicine Institutional Review Board has reviewed your request for exempt status for your study listed above. He agreed that this study qualifies as exempt from review under the following guideline: 45 CRF 46:101. It was determined that your study does not fall into the definition of Human Subject Research. You are free to conduct your study without further reporting to UT-College of Medicine Institutional Review Board.

Thank you for keeping the board informed of your activities.

Sincerely,

Stacey Hendricks, CIM
IRB Administrator

APPENDIX C**Evaluation of Stethoscopes as a Source of Bacteria Related to Nosocomial Infections**

Purpose of Project: To determine the presence of methicillin-resistant *Staphylococcus aureus* on the diaphragms of personal and unit stethoscopes within the healthcare setting before and after cleaning with 70% isopropyl alcohol prep pads.

Design: Culture of the diaphragm of personal and unit stethoscopes. Nurses, assistive personnel, and physicians will be asked to allow their stethoscopes to be swabbed, cleaned, and swabbed again. Unit stethoscopes will also be included in the sample. Participation is voluntary and only job description and type of unit will be recorded. This risk for participating is minimal, and participants will be without their stethoscopes for less than five minutes.

Setting: Medical-surgical and intensive care units of the Baroness Campus of Erlanger Health System, Chattanooga, TN.

Methods: Cultures will be obtained from 200 stethoscopes using pre-packaged sterile swabs and inoculated on a selective medium for MRSA.

Results: The frequency of contamination of stethoscopes used by different groups of health care providers (physicians, nurses, assistive personnel) and units will be determined and compared. The results will then be discussed in a formal paper and conferred to Erlanger Health System.

Dates of Data Collection: June 24th and 25th, 2010. Will contact if more dates are needed.

Questions or Comments:

Abigail Russell
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APPENDIX D
LABEL CODING PROCEDURE
EXAMPLE

In each step of the procedure, the sample was labeled with a code that corresponded with the stethoscope's location, cleaning status, and the job position of the owner. The cleaning status of the stethoscope was designated by a number. An even number indicates the swab sampled a stethoscope in pre-cleaning status, while a serial odd number indicates post-cleaning status. The abbreviated version of the unit the stethoscope was sampled on designates the location. The job position of the owner is labeled N (nurse), P (physician), U (unit/communal), or A (respiratory).

Example:

A sample taken from a physician's stethoscope in the intermediate intensive care unit that has not been cleaned would be labeled:

1PIMCU

The same stethoscope after cleaning would be labeled:

2PIMCU

APPENDIX E BACTERIAL SAMPLE PROCEDURE

Materials:

BBL CHROMagar MRSA plates (400), mark 200 as A and assign a number (pre-cleaning) and 200 as B and assign a number (post-cleaning)

Sterile swabs dampened with sterile normal saline, packaged in transport medium (400)

Sterile isopropyl alcohol, 70% v/v prep pads (200)

Cooler

Procedure

1. Gather supplies. Observe aseptic techniques.
2. Medium should be allowed to warm to room temperature in the dark before inoculation.
3. Inoculate swab from group A with the stethoscope diaphragm by rubbing sterile damp swab on surface of diaphragm, using a rotating motion of wrist. Replace swab in transport medium container, swirling swab in medium. Label sample. Place upright in cooler.
4. Open alcohol prep pad, rub on diaphragm of stethoscope in circular motion, and let alcohol dry.
5. Inoculate swab from group B by rubbing dampened swab on surface of cleaned diaphragm in motion described in step 3. Also place in cooler.
6. Inoculate plates using samples taken in the streak plate technique. Label, and invert plates.
7. Incubate all samples at 35-37° Celsius for 24 hours in dark area. If no mauve colonies are recovered, reincubate for another 24 hours.
8. After 48 hours, no MRSA is indicated if no mauve colonies exist.
9. If after 48 hours, mauve colonies present, use coagulase test to determine if coagulase positive.

BACTERIAL TAXONOMIC IDENTIFICATION

Materials

- Chart to record data (see below)
- Pan with small jar
- Crystal violet dropper bottle
- Iodine dropper bottle
- Ethyl alcohol dropper bottle
- Safranin dropper bottle
- Clean glass slide
- Culture
- Inoculating loop
- Bunsen burner
- Distilled water in squirt bottle
- Microscope with oil immersion objective
- Lens tissue
- Tubes

Procedure

1. Colony Morphology on Agar Plate

- Describe colonies based on shape, margin, elevation, and color
- Colonies of MRSA will appear mauve on the BBL CHROMagar MRSA medium.

Refer to chart.

24 hour incubation	Interpretation/Recommended Action
Mauve colonies morphologically resembling staphylococci	MRSA detected, report MRSA colonization
No mauve colonies	No results available, reincubate 24 hours

48 hour incubation	Recommended Action	Interpretation
Mauve colonies	Perform coagulase testing	If coagulase positive- MRSA detected If coagulase negative- report no MRSA
No mauve colonies	N/A	Report no MRSA

2. Coagulase test (This test is used to differentiate staphylococci by determining the ability of an isolate to clot plasma by producing the enzyme coagulase.)

1. Use rabbit plasma and reconstitute one vial at a time with sterile distilled water
2. Store refrigerated before and after reconstitution and use within 72 hours.
3. Add 0.5 mL of plasma to sterile glass tube.
4. Emulsify a large loopful of a pure colony of *Staphylococcus* into the plasma.
5. Incubate at 35°C for 4 hours, observing every 30 minutes for clot formation
6. If no visible clot at the end of 4 hours, leave at room temperature overnight and observe for clot formation. Do not shake or agitate the tube.
7. Record positive result if clot formation occurs (*S. aureus*)

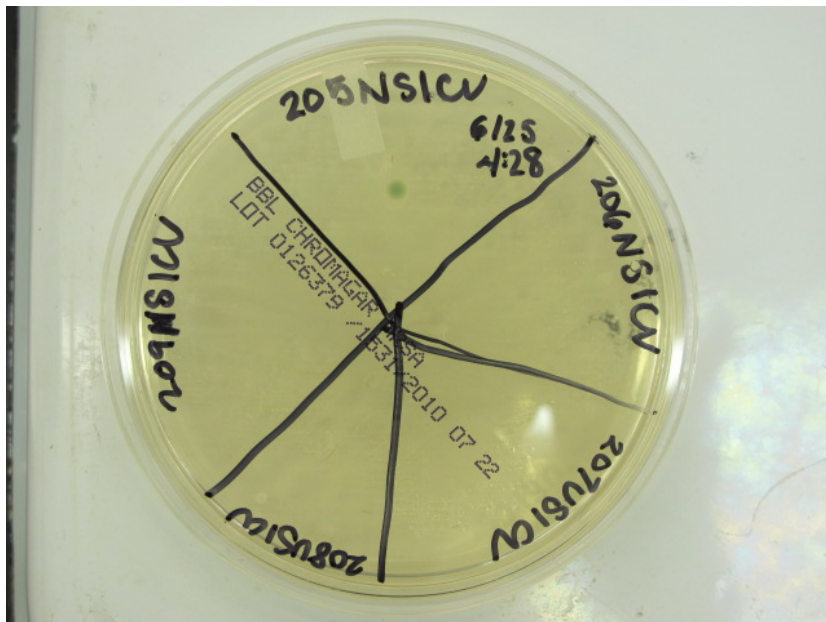
Sample Growth Record

Code	Growth at 24 h	Colony Morphology	Growth at 48 h (Coagulase +/-)	No Growth

**APPENDIX F
CONTROL PLATE**



APPENDIX G
EXAMPLES OF BACTERIAL GROWTH NOTED



**APPENDIX H
TABLES**

Table 1 Comparison of Bacterial Colonies by Role			
Role	N	Pre-Cleaning samples developing colonies	Post-Cleaning samples developing colonies
Nurse	88	2	0
Unit	35	3	0
Physician	12	1	0
Respiratory Therapy	6	0	0

Table 2 Comparison of Bacterial Colonies by Location			
LOCATION	N	Pre-cleaning samples which developed colonies	Post-cleaning samples which developed colonies
Medical-Surgical Unit	73	3	0
ICU	68	3	0
*p < 0.05; **p= 0.01			

APPENDIX I

Figure 1. EPIDEMIOLOGICAL TRIANGLE

