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The Impact Of Pre-operative Mupirocin Prophylaxis On Surgical Site Infections In Same-day Admission Open Heart Patients

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THE IMPACT OF PRE-OPERATIVE MUPIROCIN PROPHYLAXIS ON SURGICAL SITE INFECTIONS IN SAME-DAY ADMISSION OPEN HEART PATIENTS

by

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ABSTRACT

The CDC estimates that one in 20 patients admitted to the hospital is a carrier of methicillin-resistant Staphylococcus aureus (MRSA). Staphylococci are commonly found on the skin and mucous membranes within the anterior nares, which provides the principle reservoir for this organism. These organisms can go on to cause surgical site infections in hospitalized patients.

Mupirocin is an effective topical medication used to eliminate nasal carriage of Staphylococcus aureus (S. aureus). Based on Level A evidence, the 2007 Society of Thoracic Surgeons has made a Class I recommendation for the use of mupirocin for all patients undergoing cardiac surgery in the absence of documentation of a negative culture for staphylococcal colonization.

The purpose of this before-and-after study is to examine the rates of surgical site infections (SSI) for cardiac surgery patients who came through the pre-admission testing unit prior to same-day admission (SDA) for surgery before and after providing 2% mupirocin nasal ointment.

Specific aims:

1. To examine the relationship between providing mupirocin to the SDA cardiac surgery patient and the prevalence of SSI.
2. To examine the cost-effectiveness of providing mupirocin to the SDA cardiac surgery patient and SSI.
3. To examine the adherence of SDA preoperative cardiac surgery patients and the use of mupirocin preoperatively, if the medication is provided at no cost to the patient.

Retrospective chart reviews were completed on 330 patients: 175 patients in the pre-provision of mupirocin and 150 in the mupirocin provided group. Chi Square and students' t-tests were used to analyze the data.

There were five SSIs in the pre-provision of mupirocin group and no SSIs in the mupirocin provided group. This was a significantly statistical difference between the groups ($X2[1] = 4.497$, $p < 0.5$)

Continued provision of 2% nasal mupirocin to prevent SSI in the cardiac surgery patients is recommended.

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CHAPTER ONE: INTRODUCTION

Assessment of Need

Methicillin-resistant *Staphylococcus aureus* (MRSA) infection in the United States (U.S.) is a major public health concern. MRSA has been a problem with hospitalized patients since the 1960s. In 2003, 64.4% of hospital-acquired *Staphylococcus aureus (S. aureus)* infections were methicillin-resistant (Klevens et al., 2007). MRSA infections are associated with longer lengths of hospitalization, higher mortality, and increased costs. In cardiac surgery, the incidence of surgical site infections (SSIs) is generally between 1 – 8%, but mortality rates for those with a SSIs are high, with a rate around 14 – 47% (Nicholson & Huesman, 2006). Approximately 20% of these SSI are caused by MRSA, and between 30 – 100% of postoperative wound infections can be caused by autoinfection with *S. aureus* (Wenzel & Perl, 1995)

MRSA has now become endemic in many U.S. hospitals. Because of the endemic nature of the organism, MRSA is considered a risk factor for post-operative SSIs and is associated with poor clinical outcomes and higher costs of medical care. The Center for Disease Control and Prevention (CDC) has noted increases in both community- and hospital-acquired MRSA when comparing the 2001 data to the 2004 data (Centers for Disease Control and Prevention, 2007). In the United Kingdom, the Department of Health has begun mandatory reporting of MRSA infections in hospitals (Health Protection Agency, 2007). In the U.S., several states have passed bills requiring active surveillance for MRSA (General Assembly of Pennsylvania, 2007; Illinois Senate Bill 0233, 2007; State of New Jersey, Senate Number 2580, & 212th Legislature, 2008). The Healthcare Infection Control Practices Advisory Committee of the CDC has published guidelines for expanding surveillance of asymptomatic patients in certain settings (Seigel, Rhinehart, Jackson, & Chairello, 2006). The 110th Congress of the U.S. introduced Bill S2278IS,

which concerns the need to "improve the prevention, detection, and treatment of community and healthcare-associated infections (CHAI) with a focus on antibiotic-resistant bacteria" (Durbin, 2007). In a recent study, the CDC estimated that nearly 95,000 people became infected with invasive MRSA in 2005, which resulted in 19,000 deaths (Centers for Disease Control and Prevention, 2007). The annual nationwide cost to treat all hospitalized patients infected with MRSA in estimated to be more than $4 billion dollars (State of New Jersey et al., 2008).

Staphylococcus aureus and Treatment with Mupirocin

Staphylococci are commonly found on the skin and mucous membranes, with the anterior nares providing the principle reservoir for this organism. The suggested pathway for autoinfection is as follows: *S. aureus* is present in the anterior nares and then spreads via hand carriage to other body sites, where the organism can enter into breaks in the skin (Tulloch, 1954; Wenzel & Perl, 1995). This autoinfection of surgical wounds is common, and since MRSA can survive on cloth and plastic for up to 90 days, it is frequently transmitted by contaminated hands, clothes, and non-invasive instruments. The CDC estimates that one in 20 people entering the hospital carries MRSA (Centers for Disease Control and Prevention, 2007).

Although MRSA is very common in hospitals, it can be prevented by taking certain precautions. Mupirocin is an effective topical medication that eliminates nasal carriage of *S. aureus.* Based on Level A evidence, the 2007 Society of Thoracic Surgeons has made a Class I recommendation for the use of mupirocin for all patients undergoing cardiac surgery in the absence of documentation of a negative culture for staphylococcal colonization (Engelman et al., 2007). Based on this recommendation, preoperative orders to complete nasal cultures on all cardiac surgery patients and administer mupirocin preoperatively were instituted at this facility.

This is completed easily when the patient is in-house preoperatively. For patients who are seen in the office and come to the hospital the same day as surgery, the nasal cultures are done in the pre-admission testing unit with the other preoperative labs. It was providing these patients with the preoperative mupirocin that was problematic and where the gap in care occurred.

When implementing the 2% mupirocin nasal ointment prophylaxis project for the same-day surgery admission patient, the process was for the patient to be seen in the office by the surgeon, who determined if patient was a surgical candidate and who set the surgery date. The patient was then processed in Pre-Admission Testing (PAT) for preoperative labs, education, and admission paperwork. MRSA nasal cultures were completed at that time, usually within one to two days prior to surgery. The patient arrived the morning of surgery, he or she received the morning dose of mupirocin in preoperative holding, cultures were checked on arrival to the cardiovascular recovery unit (CVRR), and mupirocin was continued if cultures came back positive. If the culture's result was unavailable, the mupirocin was continued until a negative final culture was determined and the mupirocin was stopped. The problem was with the same-day surgery patient obtaining mupirocin. A prescription for the medication was given at the CV surgeons' office visit and the patient could have it filled at any pharmacy. Most pharmacies do not carry unit-dose (1 dose) 2% mupirocin nasal ointment. The patient would have to find a pharmacy that carries 2% mupirocin nasal ointment and then would have to purchase a box of 20 tubes of 2% mupirocin nasal ointment to receive one dose of the drug. This was difficult for the patient to find a pharmacy, expensive, and more medication than was needed by the patient.

Based on the Society of Thoracic Surgeons recommendation of treating all cardiac surgery patients with 2% mupirocin nasal ointment preoperatively to prevent autoinfection with

S. aureus (Richard Engelman et al., 2007), the proposed benefits of providing mupirocin to cardiac surgery same-day admit patients in PAT included but was not limited to:

- A decrease in surgical site infections in same-day admit cardiac surgery patients that are nasal carriers of S. aureus, which leads to cost savings related to decrease in length of stay for patients with surgical site infections and possible reoperations
- The psychological/psychosocial benefits for same-day admit cardiac surgery patients in experiencing a positive surgical experience
- Decrease in overall hospital, staff, and family cross contamination of S. aureus, which could lead to collateral infections.

The first benefit listed is related to the actual monies saved by preventing a sternal wound infection to the facility. The cost of caring for a patient with a sternal wound infection post cardiac surgery is approximately 2.8 times higher than an uncomplicated postoperative cardiac surgery case (Nicholson & Huesman, 2006). These costs are related to increase in prolonged hospitalization, increased health care costs, and the potential for decrease in reimbursement from Medicare due to an undocumented preoperative infection.

The second benefit pertains to the decrease in stress on an already stressed patient by providing a positive postoperative experience. Surgical complications, such as postoperative infection, increases patient complaints and dissatisfaction (Murff et al., 2006).

The costs of providing mupirocin to PAT cardiac surgery patients were considered and include the following:

- Increase in pharmacy budget to purchase mupirocin. These costs will be determined by the amount of mupirocin purchased and provided to an estimated number of same-day

admit cardiac surgery patients. This number is an estimate because the number of cardiac surgeries is declining yearly. However, the percentage of PAT/same-day cardiac surgery admits per year has consistently increased.

- Increase in education material costs due the need to print instructions on mupirocin usage to provide to the patient when given the medication.

This study will examine the impact of 2% mupirocin nasal ointment prophylaxis on preoperative cardiac patients that come into the pre-admission testing unit for preoperative testing prior for same-day admission for cardiac surgery and surgical site infections. The question to be asked is, if these patients (preoperative same-day cardiac surgery patient) are provided with 2% mupirocin nasal ointment prophylaxis and given verbal and written instructions in PAT and the pharmacy staff on administration of the medication, will a decrease in surgical site infections be observed in the same-day admission cardiac surgery patients? A related question would be, how many and what is the rate of same-day admission cardiac surgery patients who are cultured preoperatively have a positive culture?

The question of relevance to nursing knowledge and clinical practice should be addressed in relationship to the research question. The provision and treatment of all cardiac surgical patients preoperatively with mupirocin prophylaxis is a standard of care. If it is the facility's desire to provide evidenced-based care, then all the patients having cardiac surgery should receive mupirocin preoperatively. Prevention of surgical site infections is paramount in the cardiac surgery patient. Developing a sternal wound infection post-operatively is not only expensive to the organization but can potentially decrease reimbursement from Medicare,

increase mortality risk for the patient, and decrease patient satisfaction (Murff et al., 2006; U.S. Department of Health and Human Services, 2007; Wenzel & Perl, 1995).

Objectives and Aims

The objectives of the proposed study are as follows:

1. To examine the relationship between providing mupirocin to the same-day admission cardiac surgery patient and the prevalence of surgical site infections. This will be compared using the surgical site infection rate for the year prior to implementing the project.
2. To examine the cost-effectiveness of providing mupirocin to the same-day admission cardiac surgery patient and surgical site infections
3. To examine the adherence of same-day preoperative cardiac surgery patients and the use of mupirocin preoperatively.

The research question used in the project is, *is there a reduction in cardiac surgery surgical site infections after providing 2% mupirocin nasal ointment to the same-day admission cardiac surgery patients?* The variables examined included:

- MRSA positive cultures done preoperatively in Pre-Admission Testing (PAT) unit
- 2% Mupirocin nasal ointment 1-gram dose
- Surgical site infection occurring after surgery (immediate to 30 days post operatively)

Co-morbidities examined included: diabetes mellitus (Type 1 or Type 2), obesity, female gender, tobacco use preoperatively, chronic obstructive pulmonary disease (COPD), presence of preoperative infection, and use of chlorhexidine gluconate scrub preoperatively. Laboratory

parameters to be examined included hematocrit (HCT), serum creatinine (Scr), glycoslated hemoglobin (HGBA1C), and positive culture from other sites. Perioperative factors examined included receipt and timing of antibiotics, redosing of antibiotics, receipt of preoperative steroids, lowest core body temperature during surgery, transfusion of blood products, and type of cardiac surgery performed. Adherence with medication use by the patient preoperatively was examined.

The proposed question/study reviewed was a quasi-experimental design—a before and after study design. As such, it utilized a historical comparison group—the same-day admission cardiac surgery patients' data from the previous year (2007-2008) compared to the same-day admission cardiac surgery patients who received the 2% mupirocin nasal ointment, beginning December 1, 2008. Because of the quasi-experimental design, the independent variable is the use of 2% mupirocin nasal ointment provided to the same-day admission cardiac surgery patients at PAT, and the dependent variable is the occurrence of surgical site infections postoperatively in the same-day cardiac surgery patients who received 2% mupirocin nasal ointment.

The null hypothesis is that there will be no difference in the surgical site infection rate between the same-day admission cardiac surgery patients who received 2% mupirocin nasal ointment preoperatively and the same-day admission cardiac surgery patients who did not receive 2% mupirocin nasal ointment preoperatively. Therefore, the hypothesis is that there is a difference (a decrease) in surgical site infections in same-day admission cardiac surgery patients at ORMC will received 2% mupirocin nasal ointment prophylaxis preoperatively and the same-day admission cardiac surgery patients who did not receive 2% mupirocin nasal ointment prophylaxis preoperatively.

CHAPTER TWO: LITERATURE REVIEW

This chapter will review the literature in relationship to mupirocin prophylaxis in the cardiac surgery patient and surgical site infections. The review of the literature focuses on research findings related to cardiac surgery, surgical site infections, MRSA and cardiac surgery, and nasal mupirocin prophylaxis in this specific population.

Search Terms and Strategies

The key concepts researched to prepare for the proposed study included: cardiac surgery, MRSA, and mupirocin prophylaxis treatment. The literature was searched using the keywords: Methicillin-resistant *Staphylococcus aureus*, MRSA, hospital-acquired MRSA, MRSA surgical site infections, cardiac surgery MRSA infections, surgical prophylaxis for MRSA, MRSA prophylaxis, intranasal MRSA, mupirocin, mupirocin prophylaxis, mupirocin and therapeutic uses, cardiac surgery, thoracic surgery, and heart surgery. The databases utilized in the search included: Pubmed, Medline, Cinahl, and CSA/Illumina. Inclusion criteria for article selection included: English language and adult cardiac surgery population. In the database search, 38,522 articles were identified. Please see Appendix A: Table A1: Literature Search Strategies and Table A2: Mupirocin Literature Review, for the yield of articles per database. During the search, several studies were noted to be cited in multiple databases. These articles were included in the selection and review for the development of the research project.

The review of mupirocin and the effectiveness of the medication in the treatment of nasal carriage of *Staphylococcus aureus* in cardiac surgical patients are indicated if this medication is to be utilized. This section will explore the major studies in nasal carriage of S. aureus and MRSA, MRSA and cardiac surgery surgical site infections, recommendations regarding the use

of mupirocin for prevention and treatment of MRSA in the cardiac patient, mupirocin resistance, and cost benefit of mupirocin in the cardiac surgery patient.

Nasal Carriage of *Staphylococcus aureus* and MRSA

As early as 1931, the evidence regarding nasal carriage of *Staphylococcus aureus* was found in the literature. Miles (1944) examined the nasal and skin strains of S. aureus and found them to be the same. Tullock (1954) addressed the relationship with nasal carriage of *S. aureus* and staphylococcal skin diseases and determined that the sterilization of the anterior nares was needed to decrease autoinfection. He did phage typing to confirm the anterior nares as the primary source of the *S. aureus* in chronic staphylococcal dermatoses. Kluytmans, Mouton, Ijzerman, Vandenbroucke-Grauls, Maat, Wagenvoort, et.al (1995) examined nasal carriage of S. aureus as a risk factor for development of a sternal wound infection after cardiac surgery. All patients had nasal swabs done the day prior to surgery, and if they developed a sternal wound infection, the sternal wound was cultured as well. If the sternal wound grew S. aureus, then the nasal and sternal wound cultures were sent for phage typing. From the study population (1980 patients), 2%, or 40 patients, developed sternal wound infections. In 19 of the 40 cases, the patients had positive preoperative *S. aureus* nasal cultures. In 10 out of the 19 cases, the phage-typing showed that the *S. aureus* isolates were identical (Kluytmans et al., 1995). Munoz, Hortal, Giannella, Barrio, Roriguez-Creixems, Perez, Rincon, et al. (2007) examined 357 patients undergoing major heart surgery to determine the risk factors that contribute to the development of surgical site infections after open heart surgery. Nasal cultures were done preoperatively. They found that approximately 27% of patients scheduled for open-heart surgery were nasal carriers of *S aureus* before surgery, and 9.4 % of these patients had MRSA stains. The

most common isolated surgical site pathogen was *S aureus*, which was the cause of 64% of the infections in the postoperative patients. Of those *S. aureus* infections, half occurred in the patients that were identified as nasal carriers. Surgical site infections occurred in 33% of the patients identified as MRSA carriers (Munoz et al., 2007).

Treatment of Nasal Carriage of MRSA with Mupirocin

Ward and Campoli-Richards (1986) reviewed the antibacterial activity, pharmacokinetic properties, and therapeutic use of mupirocin. They found that mupirocin 2% ointment demonstrated excellent efficacy in superficial skin infections with *S. aureus* and with nasal carriage of the organism, as well as MRSA. Lanolin-based mupirocin was found to clear the bacteria within 48 hours in all patients with a treatment regimen of four times daily for five days. Casewell and Hill's (1986) study on mupirocin with a soft paragon base, as opposed to the manufactured glycol base, found that while eradicating the *S. aureus* in the nares, the glycol base caused nasal mucosal irritation. Reagan, Doebbleling, Phaffler, Sheetz, Houston, Hollis, and Wenzel (1991) did a randomized, placebo-controlled study in healthcare workers to evaluate the effectiveness of Mupirocin ointment and the elimination of *S. aureus* in nasal and hand carriage. They cultured the nares at baseline, in 72 hours after treatment with Mupirocin and at 1, 2, 4 and 12 weeks. Mupirocin was effective in eliminating *S aureus* in the nares for up to 12 weeks (Reagan et al., 1991). In 2002, Perl, Cullen, Wenzel, Zimmerman, Pfaller, Sheppard, et al. did a randomized, double-blind, placebo-controlled trail to evaluate if mupirocin was effective in reducing and preventing *S. aureus* surgical site infections as well as other nosocomial infections. In the study, 891 patients, or 23.1% of the patients, had positive *S. aureus* nasal cultures. This group was randomized into a mupirocin and placebo group. The infection rate was lower in the

mupirocin group (4.0%) than in the placebo group (7.7%). They found that prophylactic use of mupirocin did not significantly reduce *S. aureus* infections overall, but that it was significant when used in patients that were nasal carriers of *S. aureus*. (Perl et al., 2002) A meta-analysis was done in 2005 by Kallen, Wilson, and Larson from the VA Outcomes Group, Va. and found that perioperative intranasal mupirocin reduced the risk of surgical site infections in non-general surgery (cardiac) but had no effect in general surgery patients. Their analysis supports the use of mupirocin for prevention of surgical site infections in surgeries where the risk of infection with *S. aureus* is high (Kallen, Wilson, & Larson, 2005).

In a meta-analysis done by van Rijen, Bonten, Wenzel, and Kluytmans (2009) on the use of mupirocin ointment for prevention and reductions of *S. aureus* infections in nasal carriers, their review showed that the effectiveness of mupirocin in the prevention of *S. aureus* infections was related to carriers only. The review suggests the use of intranasal mupirocin eliminates *S. aureus* in approximately 80% of patients treated compared to 30% of those treated with placebo and therefore should be considered in the use of proven nasal carriers pre-operatively (van Rijen & Kluytmans, 2008). Bode (2009) presented her study at the annual Interscience Conference on Antimicrobial Agents and Chemotherapy and the Infectious Disease Society of America. In her trial, conducted in five hospitals in the Netherlands, it was found that by identifying nasal carriers of *S. aureus* and following with prompt treatment with mupirocin nasal ointment and chlorhexidine gluconate medicated soap reduced the risk of infection in those carriers. These patients were swabbed on the day of admission and started decolonization of carriers within 24 hours. Decolonization was done with mupirocin intranasal twice daily and chlorhexidine total body washes daily. They repeated this process if the patient remained in the hospital on weeks three and six. The *S. aureus* infection rate was 3.4% in the intervention group and was 7.7% in

the placebo group and the mean length of stay was lower in the intervention group as well (12 days vs. 14 days) (Bode et al., 2008).

Mupirocin Administration Timing

Mupirocin has been demonstrated in many studies to reduce surgical site infection in patients that are *S. aureus* and MRSA positive carriers when administered preoperatively. In looking at the timing of administration, the STS guidelines recommends beginning treatment after a positive culture (Richard Engelman et al., 2007). The bactericidal activity of mupirocin has been shown to cause an inhibition of growth followed by bactericidal activity, which resulted in 90 to 99% reduction in *S. aureus* at 24 hours (Parenti, Hatfield, & Leyden, 1987; Ward & Campoli-Richards, 1986). In Ammerlann, Kluytmans, Wetheim, Nouwen, and Bonten's (2009) systematic review, it was suggested that due to the effectiveness of mupirocin immediately following administration of the drug, beginning treatment in the preoperative period would eliminate *S. aureus* and MRSA prior to surgery if administered 24 hours preoperatively (Ammeriaan, Kluytmans, Wertheim, Nouwen, & Bonten, 2008).

Mupriocin Resistance

Of concern is whether resistance would develop with the use on mupirocin in all preoperative patients. The Society of Thoracic Surgeons Practice Guidelines recommends using a PCR rapid analysis and treatment of only positive cultures, but in absence of the rapid PCR test, the recommendation remains routine prophylaxis for all patients with mupirocin (Engelman et al., 2007). Mupirocin resistance has been addressed in the literature since 1995. It has been seen, however rarely, in patients treated long term with mupirocin to prevent hemodialysis or peritoneal dialysis associated infections (Wenzel & Perl, 1995). In 2005, Fawley, Parnell, Hall,

and Wilcox published the results of a four-year point prevalence study on surgery patients and the use of short-term, empirical, preoperative prophylaxis use of mupirocin in the surgical units at three hospitals. They did not find any high-level or low-level Mupirocin-resistance isolates. They examined the isolates phage typing and did not find any mutations or spread of resistant strains. They did find in long-term follow-up that mupirocin was effective in reducing the incidence of nasal carriage of MRSA and *S. aureus* (Fawley, Parnell, Hall, & Wilcox, 2006). In 2006, Shrestha, Banbury, Weber, Cwynar, Lober, Procop, et al. did a retrospective study evaluating the safety of using targeting preoperative mupirocin in preventing surgical site infections after cardiac surgery. Nasal cultures were done, and the patients were started on mupirocin preoperatively. Once the cultures results were available, the mupirocin was discontinued in the culture negative group. There was no significant difference in the infection rate between the treated carriers and non-carriers with a relative risk of 1.11. They determined that providing the mupirocin to the carriers only did not put the non-carriers at increased risk of surgical site infections in the immediate postoperative period (Shrestha et al., 2006)

Cost Benefit of Mupirocin in Cardiac Surgery

In 1996, VandenBergh, et al. assessed the cost effectiveness of perioperative intranasal use of mupirocin in cardiothoracic surgery patients. Postoperative costs for a surgical site infection were estimated to be $16,878, with the incidence of surgical site infection of 7.3%. The cost of the mupirocin was $11 per patient. The incidences of surgical site infections in the mupirocin group were significantly decreased to 2.8%. This represented a savings of $16,633, strongly suggesting that the use of mupirocin was cost effective (VandenBergh et al., 1996). Cimochowski, Harostock, Brown, Bernardi, Alonzo, and Coyle (2001) conducted a prospective

study on 992 open-heart surgery patients, examining intra-nasal mupirocin and sternal wound infections. The study found that the mupirocin group (8 of 854, or 0.9%) had a significant difference in the rate of overall sternal wound infection than the non-treated group (27 of 992, or 2.7%). The cost of the mupirocin treatment was $12.47 per patient, compared with the cost of a deep wound infection $81,018 $\pm$ $41,567 (Cimochowski et al., 2001). On August 1, 2007, the Centers of Medicare and Medicaid Services (CMS) released the final rule for 2008 hospital in-patient prospective payment system. One of the major changes in the rule is the presence of one or more preventable complications will not per the patient being allowed to be assigned to a higher-paying DRG. This rule, thus, cuts the reimbursement to the hospital for patients experiencing a listed complication. One of the 13 conditions listed in the final rule is mediastinitis after coronary artery bypass surgery.

Kallen, et al. (2005) found that surgical site infections costs the United States upwards of $1.6 billion dollars in hospital charges alone and increases hospital stay by approximately five days (Kallen, et al., 2005). Nicholson and Huesman determined in 2006, when preparing the cost analysis of their study, that the cost impact of their study, which included the cost of the nasal culture and the mupirocin, was $45,000 for the anticipated 990 patients needed for the study. They calculated the average cost of treating a deep sternal wound was $42,766 at the hospital using 2002 quality control data. When comparing the cost of providing mupirocin for 990 patients to the cost of preventing one sternal wound infection, the cost of the program was justified (Nicholson & Huesman, 2006).

Conclusion of Review of Literature

The literature review synthesis supports the need to test cost effective ways to prevent surgical infections and the use of mupirocin in the preoperative cardiac surgery patient. It provides support to provide the same-day admission cardiac surgery patient with 2% mupirocin nasal ointment and close the gap in care. The nasal mupirocin protocol developed for this project is supported and based on the evidence as well as the recommendations established by the Society of Thoracic Surgeons regarding antibiotic prophylaxis (Engelman et al., 2007). The literature provided an abundance of resources to aid in the development of the data collection tool needed to look at possible confounding variables with surgical site infections in the cardiac surgery population in question.

CHAPTER THREE: METHODS

Research Question

As stated, this study examined the rates of surgical wound infections for preoperative cardiac patients that came into the Pre-Admission Testing (PAT) unit for preoperative testing before same-day admission for cardiac surgery and surgical site infections both before and after initiating an infection prevention protocol of providing 2% mupirocin nasal ointment at no cost to the patient. The study will determine if a decrease in surgical site infections was observed in the same-day admission cardiac surgery patients after initiation of provision of mupirocin at no cost. A related question was how many and what is the rate of same-day admission cardiac surgery patients who are cultured preoperatively have a positive culture?

Objectives and Aims

The objectives of the proposed study were:

1. To examine the relationship between providing mupirocin to the same-day admission cardiac surgery patient and the prevalence of surgical site infections. This was done by comparing the surgical site infection rate for the year prior to implementing the project to the mupirocin provision group.
2. To examine the cost-effectiveness of providing mupirocin to the same-day admission cardiac surgery patient and surgical site infections.
3. To examine the adherence of same-day preoperative cardiac surgery patients and the use of mupirocin preoperatively.

The variables in this study are as follows:

- MRSA infection – A surgical site infection that cultures positive with a PCR MRSA test done in the laboratory. The CDC definition was used to determine MRSA infection.
- Mupirocin nasal ointment – Medication provided at no cost and administered the night before surgery (mupirocin 2% 1-gram unit dose) by the patient. Nasal mupirocin calcium ointment, 2% contains the dihydrate crystalline calcium hemi-salt of the antibiotic mupirocin. Chemically, it is "((alpha) E ,2 S ,3 R ,4 R , 5 S)-5-[(2 S ,3 S ,4 S ,5 S)-2, 3-Epoxy-5-hydroxy-4-methylhexyl] tetrahydro-3,4-dihydroxy-(beta)-methyl-2 H -pyran-2-crotonic acid, ester with 9-hydroxynonanoic acid, calcium salt (2:1), dehydrate." It is manufactured by DPT Laboratories in San Antonio, Texas and is distributed by SmithKline Beecham Pharmaceuticals (WebMD, 2008) (http://www.rxlist.com/bactroban-nasal-drug.htm).
- Confounding variables that could also influence surgical site infections that were examined included: demographic variables such as age, gender, discharge situations, diabetes mellitus (Type 1(DM1) or Type 2 (DM2)), obesity, gender, tobacco use preoperatively, chronic obstructive pulmonary disease (COPD), presence of preoperative infection, and the use of a preoperative shower with chlorhexadine gluconate solution. Laboratory parameters to be examined included hematocrit (HCT), serum creatinine (Scr), glucosylated hemoglobin (HGBA1C), and positive culture from other sites. Perioperative factors that were examined included receipt and timing of antibiotics, redosing of antibiotic, receipt of preoperative steroids, lowest core body temperature during surgery, transfusion of blood products, and type of cardiac surgery performed.

The level of measurement for the two selected variables is:

- Surgical Site infection – This is nominal in level of measurement. If infection is present, the identified organism is either MRSA or not.
- Mupirocin nasal ointment – This is nominal in level of measurement as well. The ointment is either used or not.

The cost of implementing the project and providing the mupirocin will be examined, looking at the pharmacy costs and labor/supplies. The cost of a sternal wound infection was determined using the facility accounting program.

Design of Study

This study was quasi-experimental because it is evaluated the effectiveness of the use of 2% mupirocin nasal use in the same-day admission cardiac surgery patient, which changed at a specific point in time, in reducing MRSA surgical site infection prevalence. This study will utilize a "non-equivalent control group before and after design" (Pollit & Beck, 2008). This design allowed for the comparison of two groups of subjects, one examined before the intervention was implemented (prior to nasal mupirocin provided preoperatively), and one group examined after the 2% mupirocin nasal ointment was provided. Because the use of nasal mupirocin is a recommended standard of care for cardiac surgery patients, randomization was not indicated or possible. The retrospective chart review data was collected on patients that were processed through PAT for same-day admission for cardiac surgery before and after the practice change in 2008 through the databases available at the hospital.

Limitations of a study with this design are many. It has been suggested that limitations include incomparability of the samples being compared in every respect except for the intervention, because of the lack of randomization. Another limitation is that the study is only

used patients at one facility, which may influence the generalization of the results although the sample population is homogeneous (cardiac surgery patients only).

The strength of the design is that it related to practice in the real world. This study is an evaluation of a process improvement program already in place. Since the provision of mupirocin was implemented, it is important to evaluate if providing the nasal mupirocin made a difference (a decrease) in surgical site infection at the facility. In addition, it is important to evaluate if the provision of mupirocin was an expense that, in reality, paid for itself by preventing the costs that are incurred from a surgical site infection.

Setting/Sample Population

The setting of this study is a 581-bed tertiary care center in the southeastern United States.

The subjects in this study were same-day admission cardiac surgery patients of the cardiothoracic surgeons with privileges to operate at the facility. The inclusion criteria for the subjects are as follows:

- 18 years of age or older
- Same-day admission cardiac surgery patient processed through the PAT unit
- Surgery types: coronary artery bypass graft surgery (CABG), valve surgery, combination of CABG/valve surgery, and other cardiac surgery patients using PAT such as ASD/VSD repair and atrial myxomas.

The exclusion criteria included patients undergoing other cardiac surgeries such as aortic aneurysm repairs, resections, and dissections.

Access to the patient data was through the PAT unit records and utilizing the facility's databases, as this was an evaluation of a process improvement project already implemented.

The sample size was calculated using an online sample size calculator program at the DSS website. The value to compare the sample percentage to was set at 3% (average surgical site infection rate according to the literature), and the study sample test value was set at 1% (the reduction expected in surgical site infection rate; value measured from sample or expected from sample) and the alpha error level or confidence level of 5% (probability of incorrectly rejecting the null hypothesis that there is no difference in the percentage values). An Alpha level of 5% corresponds to a 95% Confidence Interval and with beta error level at 50% (probability of incorrectly failing to reject the null hypothesis that there is no difference in the percentage values —assuming no difference when a real difference exists). A Beta of 50% is used in most simple calculations of sampling error. This program calculated the needed total sample size of 197 subjects (samplehttp://www.dssresearch.com/toolkit/sscalc/size_p1.asp) (DSSResearch, 2006). In 2008, 775 approximately cardiac surgical procedures were done at the facility. In 2009, approximately 741 cardiac surgical procedures were done at the facility.

Human Subjects

The study used data already recorded in patient health records. No change in treatment occurred due to inclusion in this study. The study participants were chosen using a sample of convenience and the use of nasal mupirocin is a standard of care and not experimental in nature. The choice to implement the mupirocin protocol was decided in the practice environment, independent of the research study. There were no costs or additional risks to the patients who

were included in this study. The study was done to determine whether providing mupirocin at no cost to the patient was a benefit to the patients and the facility.

Patients who received care after the implementation of the protocol received the nasal mupirocin at no cost to them. The inclusion of the same-day admission for cardiac surgery in the standard care recommended by the Society of Thoracic Surgeons (Engelman et al., 2007) and is provided to the cardiac surgery patients in the hospital preoperatively with the potential to decrease the risk of developing a MRSA surgical site infection in these patients.

The potential risks of the study to the patients included a possibility of a breach of confidentiality of personal health information. To prevent such a breach, Health Insurance Portability and Accountability Act (HIPPA) guidelines were followed. Confidentiality was maintained by assigning an identification number to each of the patients processed through the PAT for same-day admission for cardiac surgery. The primary researcher kept this log in a locked file cabinet. Once the study was completed, the personal health information and identifiers were destroyed by shredding them. This information will not be shared or reused by any other person except as required by law or the IRB's.

The study was submitted to the appropriate Institutional Review Boards (IRB) – University of Central Florida and the facility. An expedited review was requested, as the risk to the patient is minimal with the greatest risk being a breach of confidentiality; the Expedited Review Request Research Involving Human Subjects form was completed and submitted for review. The study qualified for the expedited review process as the research involved the use of materials (nasal culture results, medical records) that had been collected for use in treatment of the patients for the pending cardiac surgery and to provide the standard of care suggested by the STS guidelines. The Request for Waiver of the Requirements to Consent Subjects or Alteration

of Consent Elements and HIPAA Waiver Authorization Form was submitted to the IRB's. The HIPAA De-Identification Form was submitted as well. IRB approval from the study practice site was obtained, as well as the University IRB approval.

Instrument/Data Collection Tool

A data collection tool was developed for collection of demographic data and information regarding confounding variables that may influence development of surgical site infections. Please see Appendix F for the form. This tool allowed for the collection of demographic data and information related to the variables under study as well as confounding variables. The data collection was done by the primary researcher via chart review. The data was entered into the SPSS 16.0 program by the primary researcher.

Data Analysis

The SPSS 16.0 program was used to perform the data analysis of the study. Because the level of measurement for the variables is nominal, the statistical tests used in the study will be non-parametric in nature, Chi Square and the student t-test. The descriptive variables were measured by percentages within the groups (male/female, MRSA+/MRSA-, and Mupirocin provided/not provided). The use of Chi Square allows the evaluation of the question that the actual number of surgical site infections in the same-day admission cardiac surgery patient using nasal mupirocin with the expected number of surgical site infections in the same-day admission cardiac surgery patient using mupirocin preoperatively. The expected number was based on the comparison group of same-day admission cardiac surgery patient that did not receive nasal mupirocin preoperatively. The assumptions of Chi Square are that the data is frequent in nature, adequate sample size, measures are independent of each other, and there is a basis for the

categorization of the variables. The Chi Square uses nominal/categorical data. The first assumption was met with this study in that the data is frequency; how many MRSA surgical site infections occurred. The second assumption dealt with the sample size. As the number of same-day admission cardiac surgery patients had increased from 2006 (60) to 2007 (235), a sample size of 197 was needed in each group. A power analysis was performed to ascertain the needed sample size (197). The third assumption required that the measures are independent of each other. This was met as the patient either did receive the medication or did not, and either did have a MRSA surgical site infection or did not. The fourth assumption was that there is some theoretical reason for the categories used. This assumption was met by using the variables chosen at the beginning of the study and not changing the variables to meet the desired outcome. These are the variables that were needed: the presence of MRSA surgical site infection and the use of the mupirocin.

Plans

The goal of this project was to determine the effectiveness of provision of mupirocin prophylaxis to reduce surgical site infections with MRSA in the same-day admission cardiac surgery patients. If a reduction in the SSIs from the current rate of 2.3% to 1% occurred, the financial benefit would be examined. Since CMS is no longer reimbursing for mediastinitis after open-heart surgery, a benefit if the patient develops the wound infection and is it documented the patient had MRSA positive cultures on admission and was treated appropriately, payment would occur. Again, we continued to monitor the surgical site infections and benchmark them through the current protocols and definitions. The only additional monitoring was to determine if the patient was a same-day admit versus an in-house surgery patient. This data was presented at the

Cardiovascular Department and Collaborative Practice meetings. The established format of presentation of the results was continued in the same format so that the stakeholders—surgeons, nursing, risk management, infection control, and administration—would be able to compare the results to 2007 data without questions.

CHAPTER FOUR: RESULTS

This chapter will discuss the sample and the statistical results gathered from the retrospective chart review. The statistical analysis was completed using the statistical computer program, SPSS 16.0, Chi square and student t-test. The study sample included patients that were identified using the facility's database as being admitted into the PAT for the surgeons performing cardiothoracic surgery at the facility during the study period. These patient charts were reviewed to determine eligibility for inclusion in the study.

During the pre-mupirocin provision period from December 2007 to November 2008, in which the patient did not receive mupirocin or a prescription for mupirocin, the facility's total surgical site infection (SSI) rate for the coronary artery bypass graft population was 2.8% (13 infections per 506 procedures performed). See figure 1. While this rate was less than the National Healthcare Safety Network (NHSN) benchmark of 3.39%, the goal was to lower the surgical site infection rate.

There were 330 eligible for inclusion. One patient was omitted from the study due to the chart being closed for review. In this study, 175 patients were processed through the PAT unit prior to implementation of the provision of mupirocin at no cost to the patient and 154 patients were in the group to whom mupirocin was provided at no cost. The characteristics of both groups are summarized in Table 1. Both groups were similar in demographic characteristics, co-morbidities, preoperative antibiotics, preoperative care, surgery, postoperative care, and length of stay. Only hypertension (82.9% vs. 69.5%, p=.0004) and postoperative blood transfusions (68.6% vs. 49.4%, p=.0001) were higher in the pre-treatment group compared to the mupirocin group.

Table 1: Demographic Characteristics of Study Population

Characteristics	**No Mupirocin Provided Preadmission**	**Mupirocin Provided Preadmission**
Sex:		
Male	118 (68.2%)	99 (64.3%)
Female	55 (31.8%)	55 (35.7%)
Age – years	64.1 ± 12.2	64.7 ± 10.5
Body mass index	29.9 ± 7.4	29.9 ± 6.2
Obesity:		
< 25kg/m2	41 (23.4%)	30 (19.5%)
>25kg/m2	78 (44.6%)	62 (40.3%)
>30kg/m2	30 (17.1%)	37 (24.0%)
>35kg/m2	18 (10.3%)	15 (9.7%)
>40kg/m2	8 (4.6%)	10 (6.5%)

Table 2: Co-morbidity Characteristics of Study Population

Characteristic	**No Mupirocin Provided Preadmission**	**Mupirocin Provided Preadmission**
Diabetes:		
Type 1	4 (2.3%)	6 (3.9%)
Type 2	57 (32.6%)	53 (34.4%)
Undiagnosed at admission	2 (1.1%)	3 (1.9%)
Serum glucose, preoperative mg/dl	123.4 ± 62.4	123.7 ± 55.4
HgbA1C, preoperative	6.94 ± 1.57	6.81 ± 1.36
Hypertension	145 (82.9%)	107 (69.5%)
Smoking History:		
Current smoker	22 (12.6%)	19 (12.3%)
Ex smoker	4 (2.3%)	4 (2.6%)
Never smoked	148 (84.6%)	131 (85.1%)
COPD	38 (21.7%)	32 (20.8%)
Serum creatinine, preoperative, mg/dl	1.18 ± .76	1.06 ± .97
Steroids, preoperative	2 (1.1%)	1 (0.6%)

Table 3: Preoperative Care Characteristics:

Characteristic:	**No Mupirocin Provided Preadmission**	**Mupirocin Provided Preadmission**
Chlorhexidine scrub used:		
Home night before surgery	97 (55.4%)	85 (55%)
Preoperative unit	67 (38.3%)	62 (40.5%)
Positive MRSA Screen, preoperative	0	2 (1.3%)

Table 4: Operative Characteristics of Study Population

Characteristic	**No Mupirocin Provided Preadmission**	**Mupirocin Provided Preadmission**
Surgery:		
CABG	81 (46.4%)	65 (42.5%)
CABG/Valve	35 (20.1%)	22 (14.3%)
Valve	55 (31.6%)	59 (38.6%)
Other	3 (1.7%)	7 (4.5%)
Internal Mammary Used:		
LIMA	96 (82.7%)	65 (74.7%)
RIMA	1 (0.8%)	2 (2.2%)
BIMA	7 (6.0%)	5 (5.7%)
Preoperative Antibiotics:		
Ancef 1 gm	0	1 (0.6%)
Ancef 2 gm	156 (89.7%)	131 (85.1%)
Vancomycin	17 (9.8%)	22 (14.3%)
None	1 (0.6%)	0
Antibiotic given prior to cut, minutes	34 minutes $\pm$ 24	32 minutes $\pm$ 24
Antibiotic redosed after 4 hours	105 (60%)	89 (57.7%)
Last core body temperature in OR, degrees Celsius	36.2 $\pm$ .67	36.1 $\pm$ .86
Blood transfusion, postoperatively	120 (68.6%)	76 (49.4%)

Mortality

In the pre-provision of mupirocin group, there was one death (0.6%). In the mupirocin provided group, there were two deaths (1.3%). None of the deaths in the mupirocin provided group was attributed to infection and occurred within the first 20 days after surgery.

Table 5: Mortality

PT ID	Surgery date	Date of Death	Cause of Death	Days after Surgery
9	5/26	5/31	CVA, multi system	5
34	2/20	3/05	Respiratory, Renal, GI	13
301	7/29	8/17	Arrhythmia (PEA)	19

Surgical Site Infections

The first objective of the study was to examine the relationship between providing mupirocin to the same-day admission cardiac surgery patient and the prevalence of surgical site infections.

There were five surgical site infections in the pre-provision mupirocin group. There were no surgical site infections in the mupirocin provided group. Please see Tables 6 -11 for patient and surgical infection characteristics. There were no differences noted in the choice of preoperative antibiotics between the groups or re-dosing of antibiotics during the operation (60% vs. 57.7%). Of note, there were two patients who received antibiotics after the surgical site incision were made, one in each group. Neither patient developed a surgical site infection. Operative site infections were diagnosed in the hospital for two patients and after discharge in

three patients in the pre-provision mupirocin group. All of these infections involved the sternal wound. There were no repeating or common organisms in the infections. There were no MRSA or MSSA infections noted in the pre-provision of mupirocin group. The patients who had surgical site infections had longer length of stay, ranging from five (superficial sternal wound) to 34 days (deep sternal wound). See Table 11 for surgical site infection characteristics and treatment.

Table 6: Demographic Characteristics of Surgical Site Infection Population

Characteristics	
Sex:	
Male	4 (80%)
Female	1 (20%)
Age – years	65 ± 9.13
Body mass index	30.89 ± 4.84
Obesity:	
< 25kg/m2	2 (40%)
>25kg/m2	1 (20%)
>30kg/m2	1 (20%)
>35kg/m2	1 (20%)
>40kg/m2	0

Table 7: Co-morbidity Characteristics of Surgical Site Infection Population

Characteristic	
Diabetes:	
Type 1	0
Type 2	3 (60%)
Undiagnosed at admission	0
Serum glucose, preoperative mg/dl	115.8 $\pm$ 36.7
HgbA1C, preoperative	6.5 $\pm$ 1.5
Hypertension	5 (100%)
Smoking History:	
Current smoker	0
Ex smoker	0
Never smoked	5 (100%)
COPD	0
Serum creatinine, preoperative, mg/dl	2.3 $\pm$ 2.7
Steroids, preoperative	0

Table 8: Preoperative Care of Surgical Site Infection Characteristics:

Characteristic:	
Chlorhexidine scrub used:	
Home night before surgery	2 (40%)
Preoperative unit	1 (20%)
Positive MRSA Screen, preoperative	1 (20%)

Table 9: Operative Characteristics of Surgical Site Infection Population

Characteristic	
Surgery:	
CABG	1 (20%)
CABG/Valve	1 (20%)
Valve	3 (60%)
Other	0
Internal Mammary Used:	
LIMA	2 (40%)
RIMA	0
BIMA	0
Preoperative Antibiotics:	
Ancef 1 gm	0
Ancef 2 gm	4 (80%)
Vancomycin	1 (10%)
None	0
Antibiotic given prior to cut, minutes	40 $\pm$ 33
Antibiotic redosed after 4 hours	3 (60%)
Last core body temperature in OR, degrees Celsius	36.3 $\pm$ .5
Blood transfusion, postoperatively	4 (80%)

Table 10: Surgical Site Infection Characteristics:

Characteristic:	
Surgical Site Infection Diagnosis:	
In Hospital	2 (40%)
After Discharge	3 (60%)
Re-admitted with surgical site infection	3 (60%)
Infected surgical site:	
Sternal	5 (100%)
Organism:	
S. aureus	2*
Proteus maribilis	1
Mycobacterium abscessus	1
Klesbiella oxytoca	1*
Enterobacter aerogenes	1

Table 11: Characteristics of Patients with Operative Site Infections

ID	Age	Gender	Surgery	Infected wound	Diagnosed days after surgery	Organism	Antibiotic therapy	LOS
152	57	M	CABG	Superficial sternal	29 days	S. epidermiditis	zosyn	5
257	72	M	CABG/MVR	Deep sternal	42 days	Mycobacterium abscessus	Cefoxitin, biaxin, bactrim	25
263	76	M	AVR	Deep sternal	16 days	Klebsiella oxytoca	Rocephin, cipro	34
284	55	M	CABG/AVR	Deep sternal	9 days	Enteribacter aerigenes	Maxipime, vancomycin	28
326	65	M	CABG/AVR	Deep sternal	14 days	Proteus mirabilis	rocephin	22

The patients with surgical site infections were similar in demographic characteristics to the pre-provision of mupirocin and provided mupirocin group with sex, more males than females; age (65 $\pm$ 9.13 vs. 64.1 $\pm$ 12.2 years), and BMI (30.89 $\pm$ 4.84 vs. 29.9 $\pm$ 7.4). In co-morbities, in the SSI group 60% were diabetics, Type 2 vs. 32.6% of the pre-provision mupirocin group. However, the serum glucose on admission was slightly lower (115.8 $\pm$ 36.7 mg/dl) than the pre-provision mupirocin group (123.4 $\pm$ 62.4mg/dl). The entire SSI group had hypertension vs. the 82.9% of the pre-provision of mupirocin group. The serum creatinine was higher in the SSI group (2.3 $\pm$ 2.7 mg/dl) vs. the pre-provision mupirocin group (1.18 $\pm$ .76). 80% of the SSI group had valve or combination valve surgery vs. the pre-provision group the majority of the surgeries were straight coronary artery bypass graft surgeries. The choice of preoperative antibiotic was predominately the same for both groups – Ancef 2gm IV on induction in operating room. Antibiotic administration time was similar as well (40 $\pm$ 33 minutes vs. 34 $\pm$ 24 minutes). Core body temperature was similar as well (36.5 $\pm$ .5 vs. 36.2 $\pm$ .67 degrees Celsius). Blood

transfusions were given in 80% of the SSI group and 68.6% of the pre-provision mupirocin group.

Chlorhexidine Shower

An order for chlorhexidine (CHG) shower the night before and the morning of surgery was in place prior to implementation of provision of mupirocin at no cost to the patient. However, noted prior to implementation of the provision of mupirocin that the patients were being given a different scrub solution than CHG at PAT. This was changed and CHG was given to the patient at the same time as the mupirocin. There was no difference between the groups in documentation of the shower the evening prior to surgery (55.4% vs. 55%) and the morning of surgery (38.3% vs. 40.5%). However, in the patients that developed a SSI, only one patient had the CHG shower documented as done the evening and morning of surgery and four did not.

Impact of Mupirocin

After completing the chart review and the final analysis of the study using Chi square to compare the frequency of surgical site infections for the pre-mupirocin and mupirocin provided groups, a significant difference between the groups was found ($X^2(1) = 4.497$, $p < 0.5$).

The facility's infection control program records SSI in the cardiac surgery patient separately – CBG and other cardiac procedures (MVR, AVR, pericardial window, septal surgeries) due to the NHSH benchmark is different for these populations.

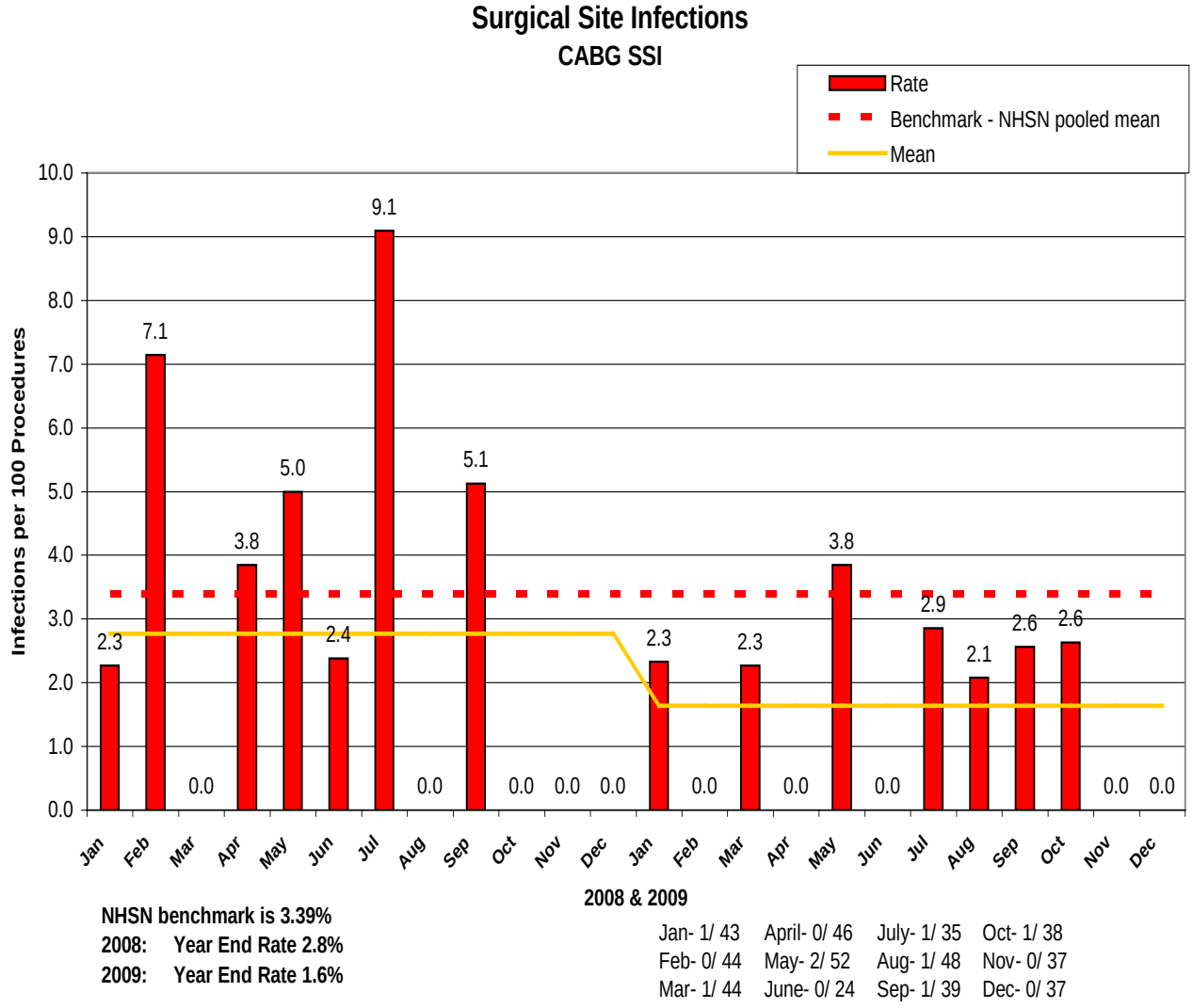
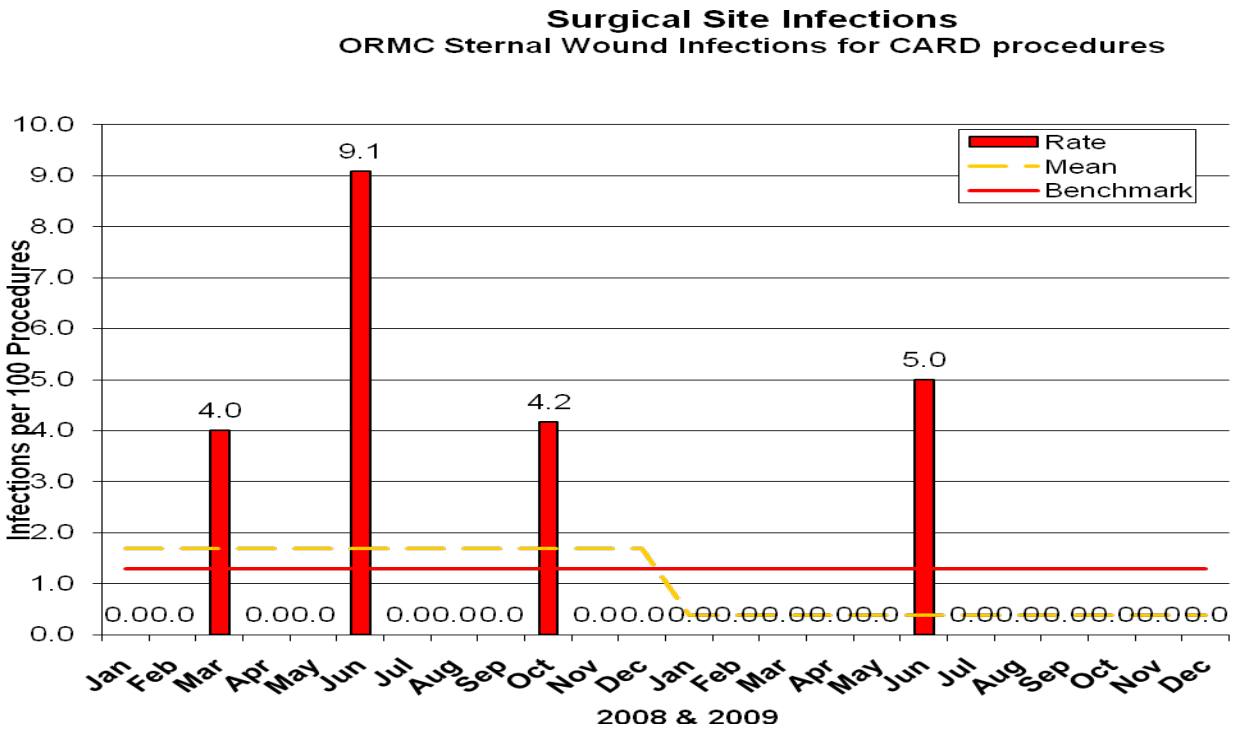


Figure 1: Surgical Site Infections

As noted in Figure 1, the mean trend line (2.8% rate) indicated that the surgical site infections in the CABG population only at the facility was below the NHSN benchmark (3.339% rate) prior to the implementation of provision of mupirocin to the same-day admission open heart patients. After implementation of provision of mupirocin and correcting the CHG scrub given to the

patient in PAT the infection trend line had a significant drop (1.6% rate). This was a 43% reduction in surgical site infections in coronary artery bypass graft patients at the facility.

In Figure 2, the mean trend line in the other cardiac surgery patients (1.7% rate) indicated that the surgical site infections in the other cardiac surgery population only at the facility was above the NHSN benchmark (1.4% rate) prior to the implementation of provision of mupirocin to the same-day admission open heart patients. After implementation of provision of mupirocin and correcting, the CHG scrub given to the patient in PAT the infection trend line had a significant drop (0.4% rate). This was a 75% reduction in surgical site infections in other cardiac surgery patients at the facility.



NSHS Benchmark 1.3%; 2008 Year End Rate 1.7%; 2009 Year End Rate 0.4%

Figure 2: Other Cardiac Surgery SSI

Cost Analysis

The second objective was to examine of the cost-effectiveness of providing mupirocin to the same-day admission cardiac surgery patient. The length of stay (LOS) did not show any differences between groups. Average LOS for the pre-provision of mupirocin group was 8.38 $\pm$ 4.45 days and the average LOS for the mupirocin provided group was 8.44 $\pm$ 4.6 days. The average LOS of the patient with a surgical site infection was 22.8 $\pm$ 10.89 days. The average cost (direct and direct costs) for patients in the pre-provision of mupirocin group was $22,709 and the mupirocin provided group was $24,350. The average cost (direct and indirect) of the patient with a surgical site infection was $37,905.

Mupirocin Treatment

The third objective of the study was to examine the adherence of same-day preoperative cardiac surgery patients with the instruction to use of mupirocin preoperatively. There were 154 patients processed through the PAT during the provision of mupirocin period. The mupirocin was provided to the patients through the hospital outpatient pharmacy. Review of the medication dispensed record in the pharmacy and billing records indicated that 111 patients picked up the medication on the day of PAT (71.4%). Therefore, 44 patients did not pick up the medication per pharmacy records. The use of the mupirocin the night prior to surgery was not documented in the preoperative record as medication taken at home in the mupirocin provided patient group.

CHAPTER FIVE: CONCLUSION

This chapter will discuss the findings of the study related to the study questions, limitations of the study, conclusions, and implications for nursing as well as recommendations for further projects related to the outcomes of this study.

Discussion

The first objective of the study was to examine the relationship between providing mupirocin to the same-day admission cardiac surgery patient and the prevalence of surgical site infections. This was accomplished by comparing the surgical site infection rate for the year prior to implementing the provision of mupirocin to the same-day admission cardiac surgery patient.

The reduction of infections found in the mupirocin group was significantly different from the pre-provision of mupirocin group ($X^2(1) = 4.497$, $p < 0.5$). This finding supports the study by VandenBergh et al. (1996) who found a decrease in SSI of 2.8% by implementing mupirocin preoperatively in cardiothoracic surgery patients. This is supported as well in the study by Cimochowski, et al. (2001) who had a decrease of SSI in the mupirocin group of 0.9% vs. 2.7% in the non-mupirocin treated group. The Class I recommendation of the society of Thoracic Surgeons strongly suggested treatment with mupirocin for patients with positive nasal cultures (2007). The implementation of this process improvement met the recommendation for treatment of all the cardiac surgery patients at the facility.

While the STS recommendation is for treating only culture positive patients, this study provided medication and treated all patients until the culture results were posted. A negative culture results takes 48 hours to obtain, and a positive culture is able to be diagnosed in 24 hours using the BBL CHROMagar MRSA test at the facility. In this study, no patients developed an

adverse reaction to the mupirocin. The average number of doses received in the hospital for the mupirocin provided group was 2.87 doses $\pm$ 2. In this study, the two patients that had positive cultures were treated with five days of mupirocin; however, the preoperative antibiotic choice was only changed to vancomycin for one patient.

Objective two addressed the cost effectiveness of providing mupirocin to the same-day admission cardiac surgery patient. This was evaluated by the average cost for the average hospitalization for the patients, both pre-provision of mupirocin and provision of mupirocin groups and examination of the cost of care for the SSI patient group compared to the non-SSI in the pre-provision mupirocin patient group.

There was no difference noted in length of stay (LOS) of the two groups. The average LOS of the pre-provision of mupirocin group was 8.38 $\pm$ 4.45 days and for the mupirocin provided group was 8.44 $\pm$ 4.6. The average LOS of the surgical site infection group was 22.8 $\pm$ 10.89 days. This is different from Kallen et al. (2005) who found that SSI increased length of stay by approximately five days. While this study shows no difference in length of stay between the two groups, there is a difference in the LOS between the pre-provision of mupirocin group and the surgical site infection group.

The cost of the average length of stay for the cardiac surgery patient at the facility during the study period was $22,709 for the pre-provision of mupirocin and $ 24,350 for the provision of mupirocin group. The average cost of care for the surgical site infection patient was $37,905. The difference in the hospital costs of the two groups with the provision of mupirocin group being higher than the pre-provision mupirocin group is more likely related to increased hospital costs and the global economy rather than the provision of the mupirocin. The cost of providing the PAT patient with the mupirocin was $4.00. A total of 111 patients picked up the mupirocin at

the pharmacy, for a total expense of $444.00. The average cost for the SSI patient, when compared to the pre-provision of mupirocin average cost is 40% higher. Even when compared to the provision of mupirocin group average cost, the SSI average cost is 36% higher. This supports Nicholson and Huesman's (2006) suggestion that the cost of one SSI more than justifies the expense of providing the mupirocin.

Objective three examined the adherence of same-day preoperative cardiac surgery patients and the use of mupirocin preoperatively, if provided at no cost. In the hospital, the nursing staff administers mupirocin the night before surgery and patient adherence to the treatment regimen is easy to ascertain. For patients coming into the hospital the morning of surgery, who must self-administer the mupirocin prior to coming into the hospital, the patient must be educated on the importance of mupirocin, understand how to administer the mupirocin, and must pick the mupirocin up from the pharmacy. The treatment regimen is dependent on the patient's understanding of the importance of the medication and the adherence to therapy.

In this study, only 72.5% of patients in the mupirocin group actually picked up the mupirocin from the pharmacy. While an obvious solution would be to provide the mupirocin to the patient in PAT, it is in reality not a solution since mupirocin is a prescription medication and must be dispensed to the patient according to the rules and regulations of the state for maintaining and dispensing medications. If the hospital is to continue to supply the mupirocin to the same-day admission patients at no charge, this failure to adhere to therapy is must be addressed.

Actual use of the mupirocin was not well documented for the 111 patients that did pick up the medication from the pharmacy. The SIS electronic medical record program used at the facility did include a list of all home medications and had good documentation regarding last

dose of these medications. However, there is no place to document mupirocin used the evening prior to surgery as a home medication except as part of the narrative note of the nurse. Documentation of the use of the chlorhexidine (CHG) shower found to have a similar problem. Therefore, it was not possible to accurately determine adherence with use of the medication of the patients that did indeed pick up the medication from the pharmacy after PAT.

Identification of Limitations

There are many limitations of this study. These include the lack of randomization by using a sample of convenience. The use of only one facility limits the ability of generalizing the results to other cardiac surgery sites. The small sample size is also a limitation. It was determined that a sample size of 197 patients in each group would be necessary for this study. However, as this study was retrospective, there were only 330 patients eligible to be included in the study. The lack of documentation in the SIS system of mupirocin use the evening before surgery for the patients that picked up the medication led to the assumption that if the patients did pick up the medication, then they used the medication. This may not be an accurate assumption. The concurrent change in the pre-operative soap solution to the appropriately ordered CHG soap solution also limits the study ability to attribute the change in infection rate to mupirocin provision only.

Conclusions

Munoz et al. (2007) examined the prevalence of MRSA in patients prior to open heart surgery and found that approximately 27% of patients scheduled for surgery were nasal carriers of *S. aureus,* and 9.4% had MRSA strains of *s. aureus*. Colonization with *S. aureus* is associated with increased SSIs due to self-inoculation (Kluytmans et al., 1995). Decolonization with

mupirocin has been demonstrated to be an effective treatment to prevent SSIs in the cardiac surgery population (Kallen et al., 2005). This is important if same-day admission patients at this facility were not receiving the preoperative mupirocin as ordered to prevent a surgical site infection. If a prescription was given to the patient in the surgeon's office, prior to the hospital's provision of mupirocin, the patient had trouble in finding a pharmacy that carried unit-dose mupirocin and did not take the medication as prescribed, thereby placing the patient at risk of developing an SSI.

Surgical site infections can be devastating for cardiac surgery patients, increasing length of stay, increasing costs of services, and increasing the risk of mortality. Prevention of SSIs are paramount in this population and is addressed by the Society of Thoracic Surgeons (2007) in the recommendations for preoperative antibiotics (Ancef or Vancomycin), showering with CHG prior to surgery and the use of mupirocin if the patient has a positive MRSA nasal culture. Munoz, et al. (2007) examined patients (337) prior to having open heart surgery and found approximately 27% were nasal carriers of *S. aureus*, and 9.4 had the MRSA strain. Van Rijen, et al. (2008) review of the literature suggests that approximately 30% of patients entering the hospital are MRSA carriers. This supports the intervention by which all patients are provided with mupirocin at no cost after the PAT visit. While this study found that only 1.3% of the mupirocin provided group had positive nasal cultures; this difference might be due to the fact this study's cohort was much smaller.

Decolonization of the nasal mucosa prior to open heart surgery needs to started approximately 24 hours prior to cut time. This means that the patient needs to begin the use the mupirocin no later than the evening prior to surgery at home.

The reduction in SSI seen in this study group was significantly more than the previous year when the patients were provided with a non-CHG soap product and received no mupirocin. Brode, et al. (2008) in a study, done in five hospitals in the Netherlands, found that MRSA carrier patients were decolonized with mupirocin and CHG baths. They found that the mupirocin and CHG group had significantly less SSI (3.4% vs. 7.7%) and LOS was lower as well (12 days vs. 14 days). This study provided same-day admission patients the mupirocin and CHG soap solutions and education regarding the use and timing of the shower and administration of drug at PAT. In this study, CHG shower the night before surgery was documented in the mupirocin provided group 55%. This was similar to the 55.4% rate found in the pre-provision of mupirocin/CHG group

Other risk factors that could influence the development of SSI in the cardiac surgery patients were examined and found to be similar in both groups. The mean age in this study is 64.7 $\pm$ 10.5 years, which is similar to Konvalika et al. (2006) finding of 62.5 $\pm$ 10.8 years and Munoz et al. (2007) finding of 64 years, Cimochowki et al.(2001) finding of 66.1 years. Gender findings are similar as well; more men than women were admitted through the PAT (64.3% and 35.7% in the mupirocin provided group). Obesity is a risk factor for SSI, and in this study's the BMI findings (29.92) were similar to Perl et al. (2002) of 28.9 but higher than Cimochocwki et al. (2001) of 19.3. Diabetes can affect the surgical patient and wound healing; in this study, diabetes was found in 42% of the patients in the mupirocin provided group, of which two were unknown diabetics at admission. This result is higher than Konvalika, et al. (2006) who reported 28.5% prevalence of diabetes in his treatment group. Nelson and Dries (1986) had a lower prevalence of diabetics as well, 8.7%. The preoperative orders at this facility include the measurement of a reflex HBGA1C if the preoperative serum glucose is greater than 120mg/dl.

The average serum glucose in this study was 123.7 ± 55.4mg/dl, which is similar to the non-mupirocin group's findings of 123.4 ± 62.4 mg/dl. The average HGBA1C in this treatment group was 6.81 ± 1.36; however, it was noted that the reflex HGBA1C was not done in five patients in the total study group. The number of CABG cases included in this study was 42.5% and 46.6%, and the number of valves included was 38.6% and 31.6%. Combination cases, such as CABG/Valves were higher in the pre-mupirocin group 20.1% vs. 14.3%.

In evaluating the cost benefit of mupirocin to the cardiac surgery patient, one surgical site infection is far more costly than the cost of the provision of mupirocin to all the same-day admission patients. This has been supported by Van den Bergh et al. (1996), Cimochowski et al. (2001), Kallen et al. (2005), and Nicholson and Huesman (2006) and is confirmed by the average cost for the pre-provision of mupirocin group compared to the average cost of the surgical site infection patient, $24,350 vs. $37,905. The cost of the SSI is 40% higher than the non SSI-patient in the pre-provision of mupirocin group. The cost of providing the mupirocin to the 111 patients that picked the medication up at the pharmacy was $444.00. When examining the fact that no patients in the provision of mupirocin group developed a SSI; the difference between the cost of the mupirocin and the savings realized by preventing the increased cost of providing care to the patient is evident.

Implications for Nursing

This study evaluated a process improvement project that was implemented to meet the recommendations of the Society of Thoracic Surgeons (2007) and to decrease surgical site infections. This improvement process required collaboration between many departments in the hospital. Working together with the nurse practitioner coordinating, PAT, outpatient Cardiac

Rehabilitation department, Preoperative Unit, Pharmacy, Administration, and Security, as a team was able to develop a process to overcome the perceived barriers of the same- day admission patient to provide the mupirocin. This collaboration between departments was instrumental in providing this medication to the same-day admission cardiac patient. This study illustrated the value of such collaboration by a team, in which a nurse practitioner has a significant role in the design and implementation of care.

The result of decreased surgical site infections in this population by providing mupirocin supports the need to address other surgical patient populations that use the PAT. These patients may benefit from the use of mupirocin, CHG soap solution or both. In the orthopedic population, for example, the provision of CHG solution or wipes could provide benefit in reducing surgical site infections and would require collaboration such as this improvement project.

The documentation problems that were discovered during the study were an incidental finding. The issue had to do with the electronic medical records (EMR) and difficulty documenting the use of the mupirocin and CHG shower the evening prior to surgery. The PAT nurses created the home medication list in the EMR and the Preoperative nurse documented the last dose of the home medication in the EMR, but the mupirocin and CHG were not listed on the home medication list and therefore the preoperative nurse did not have a cue to raise the question of the last dose. Identification of needed revisions in the EMR documentation as clinical processes are changed is essential. Informatics must be involved to assure that documentation issues are addressed prior to implementation of a study (to be sure needed documentation of study components can occur using existing forms) and whenever practice process are changed.

Another incidental finding regarding smoking history arose during this study. It was noted that a large portion of both groups were recorded as never smoked (85.4% and 85.1%)

compared to the ex-smoker question (2.3% and 2.6%). When looking at the patients with documented COPD (21.7% and 20.8%), one questions the validity of the smoking history results. If the nurse asking the question on the history form asks, “Do you smoke?” vs. “Have you ever smoked?”, the answer would be recorded differently. This is a nursing education issue and will be addressed with the facility’s unit based educators for staff education and reinforcement.

Recommendations for Further Projects

One of the issues that arose from this study was the lack of 100% patient participation with the pickup of the mupirocin. This medication was provided at no cost to the same-day admission cardiac surgery patient. One wonders what the barriers were for the 42 patients that did not pick up the medication, since cost of the medication was not an issue. A future study may be warranted to look at the barriers to adherence in this population so to improve the use of the medication.

A possible confounding variable that made interpretation of the results of this study difficult was the concurrent correction of the shower solution being provided to the patient at the same time as the provision of the mupirocin occurred. A study on providing mupirocin, where the patients are already receiving CHG shower would more clearly evaluate the impact of the mupirocin as a new intervention.

Diabetic control is important in prevention of surgical site infections in the post open-heart patient. In the SSI group, diabetes was documented in 60% of the group. Evaluation of the glycemic control during the first 48 hours after surgery in the SSI group would be interesting to examine. If there were periods of hyperglycemia in these patients, the examination of glucose

management would be indicated for nursing's' adherence with the use of the facilities insulin drip guideline and rate of surgical site infections.

Blood transfusions were noted to be used in 80% of the SSI patients vs. 68.6% of the pre-provision of mupirocin group vs. 49.4% in the mupirocin–provision group. Blood transfusions postoperatively increase the immune response and could potentially increase the risk of SSI. Examination of the use of blood products in the open-heart surgery patient at the facility and compared to the STS benchmark for like facilities would be warranted to evaluate the practice patterns with transfusions.

Pre-operative serum creatinine levels were elevated in the SSI group compared to the pre-provision of mupirocin group (2.3 ± 2.7 vs. $1.18 \pm .76$). However, the median serum creatinine level was 1.1. Therefore, were the patients that developed SSIs and had renal insufficiency or considered end-stage renal disease at a higher risk, and is this specific disease state one that may have affected the patient's immune system and pre-disposed them to the development of SSIs? This relationship needs to be examined more closely.

Another area for future research would be examination of the benefit of providing no cost CHG to other surgical populations that use the PAT for pre-operative testing, such as patients having orthopedic surgery. While the use of Mupirocin in other populations is not supported in the literature, the use of CHG solution is. The provision and education of CHG solution or wipes could impact the surgical site infections in other surgical populations as well.

Brief Summary

This study examined the impact of the provision of mupirocin to the same-day admission cardiac surgery patient on surgical site infections. A significant decrease in surgical site

infections was seen, the mupirocin provided group had no surgical site infections in the year after beginning the provision of the medication compared to the five surgical site infections seen in the same-day admission patients processed through the pre-admission testing unit the year prior to the provision of mupirocin. However, because the provision of CHG solution to the same-day admission patients was corrected at the same time as the provision of mupirocin the decrease in surgical site infections cannot be attributed to the mupirocin alone. The decrease in infections could be related to the mupirocin, the CHG solution, or the combination of both. The facility demonstrated at 43% reduction in SSI in the total CABG patient population after implementing the mupirocin for the total population and a 75% reduction in other cardiac surgery total population—in-house as well as same-day admission patients and the provision of 4% CHG soap to the same-day admission patients. By utilizing a nurse practitioner lead and a collaborative team approach to implement this evidence-based practice, the facility and the patients have benefited.

APPENDIX A: LITERATURE REVIEW SEARCH STRATEGIES MATRIX

Date	Database	Keywords Used	Restrictions to Search	Other Information	Yield
9/17/08	CSA/Illumina	Mupirocin/Cardiac surgery	None		13
9/24/08	Ovid/Medline	MRSA	none		591
		Hospital-acquired MRSA	None		437
		MRSA surgical site infections	None		504
		Cardiac surgery MRSA infections	None		518
		MRSA prophylaxis	None		592
		Surgical prophylaxis for MRSA	None		709
		Intranasal MRSA	None		626
		Mupirocin	None		438
		Mupirocin prophylaxis	None		511
9/28/08	Ovid Medline	Mupirocin and Therapeutic uses	None, Human, Staph Aur		235, 224, 141
		Thoracic/Cardiac surgery	Human, Post-op complications		25,464, 3,924
		Mupirocin and MRSA and Cardiac surgery	None		5
	Pubmed	Mupirocin and MRSA and Cardiac Surgery	None, English		8, 7
		Mupirocin prophylaxis and Cardiac surgery	English, Adults		16, 1
		MRSA and Cardiac surgery	English		14
	Cinahl	Heart surgery and mupirocin	Surgical wound infections		3,036
		Heart surgery and mupirocin	Antibiotic prophylaxis, Surgical		10

Date	Database	Keywords Used	Restrictions to Search	Other Information	Yield
			wound infections		
		Heart surgery and mupirocin	English, adult		469
		Heart surgery and mupirocin	Staphylococcus aureus		29

APPENDIX B: MUPIROCIN REVIEW ARTICLES

Authors	Year of Publication	Article Focus
Carrier, et al.	2002	Use of mupirocin to control and decrease MRSA after cardiac surgery
Clancy, et al.	2006	Active screening for MRSA as a cost effective intervention to decrease MRSA infections
Engelman, et al.	2007	Society of Thoracic Surgeons Practice Guidelines
Fawley, et al.	2005	Repeat point-prevalence surveillance regarding developing mupirocin resistance post operative
Jog, et al.	2008	Use of PCR screening and treating positive cultures with mupirocin
Kallen, et al.	2005	Meta-analysis review of intranasal mupirocin and the prevention of surgical site infections
Klevins, et al.	2007	Population surveillance regarding prevalence of MRSA in the hospital and community
Kluytmans & Wertheim	2004	Overview of nasal carriage of *Staphylococcus aureus* and prevention of nosocomial infections
Konvalinka, et al.	2006	Prophylaxis use of mupirocin post cardiac surgery and reduction of surgical site infections
Laupland & Conly	2003	Evidence-based Review of treatment of *Staphylococcus aureus* colonization and prophylaxis for infection with topical intranasal mupirocin.
Martorell, et al.	2004	Indentifying and treating outbreaks of MRSA with intranasal mupirocin does decrease rates of infections in CBG patients.
Mastoraki, et al.	2008	Strategy for preventing MRSA in cardiac surgery patients
Nicholson & Huesman	2006	Indentifying and treating *staphylococcus aureus* carriers with intranasal mupirocin does impact deep sternal wound infections in cardiac surgery patients.
Perl, et al.	2002	Treatment with intranasal mupirocin can reduce the rate of nasal carriage of MRSA and prevention of postoperative *Staphylococcus aureus* infections
Robicsek, A, et al.	2008	To examine the effect of 2 expanded surveillance interventions on MRSA disease – comparing rates of MRSA clinical disease during and after hospital admission in 3 consecutive periods (baseline – 12 months, MRSA surveillance for all admission to the ICU – 12 months, and universal MRSA surveillance for all hospital admissions – 21 months)
Shrestha, et al.	2006	Safety of treating cardiac surgery patients with intranasal mupirocin
Trautmann, et al.	2007	Overview of intranasal mupirocin prophylaxis in elective surgery – cardiac surgery patients.

Authors	Year of Publication	Article Focus
Tulloch, L.	1954	Compare phage typing of intranasal cultures and skin/wound cultures in same patient.
Ward & Campoli-Richards	1986	A review of mupirocin, its antibacterial activity, pharmacokinetic properties and therapeutic uses
Wenzel & Perl	1995	Significance of nasal carriage of Staphylococcus aureus and the incidence of postoperative wound infections

APPENDIX C: LITERATURE REVIEW MATRIX

Authors	Yr Pub	Country	Independent Variable	Depend Variable	Study Design	Sample Size	Study Info	Sample Method	Test Used	Valid/ Reliable
Banbury, M.	2003	USA –Ohio	Light Cycler PCR assay compared to the culture-guided treatment	Delay in treatment times	Cost benefit/ cost effectiveness model	239	If screened +, then treated with mupirocin for 5 days with 1gm bid	convenience	PCR, discord result confirmed with PNA FISH test	reliable
Carrier, M., et al.	2002	Canada	Anti-MRSA preventive measures	Incidence of MRSA infection after cardiac surgery	Retrospective, case control	13,199	Screened preop, if + received mupirocin and vanco IV preop,	convenience		Not discussed
Fawley, W, et al.	2005	UK	Mupirocin resistance with 5 day peri-operative prophylaxis regimen	Reduction in surgical site infection with no MRSA resistance	Multi-ward, prospective	593	Ortho and vascular patients treated 5 days preop with mupirocin and tricloan shower prior to surgery	convenience	Cultures – latex agglut.	Reliability
Jog, S. et al.	2007	UK	Mupirocin intranasal	Reduction in surgical site infection d/t MRSA for cardiac surgery patients	Observational cohort	1,462	Mupirocin for all patients after MRSA screen on admission to hospital– d/c after nag culture, cont for 5 days for + screen	convenience	IDI MRSA PCR	Reliable test, results confirmed by additional cultures
Kallen, A., et al.	2005		Perioperative intranasal mupirocin	Reduction in surgical site infect-ions	Meta-analysis					
Klevens, R., et al.	2007	USA	Describe the incidence and distribution of invasive MRSA	No differences in populations	Multi-site, active, population based surveillance in the Active Bacterial	8,987 cases	+ MRSA cases reviewed,	Population based		

Authors	Yr Pub	Country	Independent Variable	Depend Variable	Study Design	Sample Size	Study Info	Sample Method	Test Used	Valid/ Reliable
			in 9 US communities and to estimate the burden of invasive MRSA infections in USA in 2005	with occurrence of MRSA	core surveillance/E-merging Infections Program Network.					
Kluytmans, J, & Wetheim, H.	2004	Netherlands	Mupirocin use for MRSA nasal carriers	Surgical site infections	Review					
Konvalinka, A., et al.	2006	Canada	Mupirocin for + MRSA nasal carriers only	Reduction in surgical site infect-ions	Random Double Blinded, Placebo controlled	263	Cultured 2 weeks prior to admission for elective OHS Mupirocin BID Chlorhexidine shower preop and surgical site cleansing preop Preop antibix – cefazolin/clindamycin	convenience	Star-swab	Not discussed
Laupland, K., & Conly, J.	2003	Canada			Evidence-based Review					
Martorell, C., et al.	2004	USA - Mass	Mupirocin intranasal and clorhexidine preop shower	Reduction in surgical site infections	Observational	6,465	No culture done, all possible cardiac patients treated with 3 days of nasal mupirocin and showering with chlordexidine	convenience		
Nicholson, M, et al.	2006	USA - Ohio	Nasal culture and nasal mupirocin bid	Reduction in surgical site infection	Prospective	1,077	All patients cultured, intranasal mupirocin started preop, cont until neg	convenience	Oxoid penicillin binding	reliable

Authors	Yr Pub	Country	Independent Variable	Depend Variable	Study Design	Sample Size	Study Info	Sample Method	Test Used	Valid/ Reliable
				after cardiac surgery			culture bid, if + then mupirocin for total of 14 doses, if neg then mupirocin d/c'd		protein latex agglutination	
Perl, T, et al.	2002	USA	Intranasal mupirocin	Reduction of s. aureus infection surgical sites	Randomized, double blind, placebo-controlled	3,864	Screened preop			
Robicsek, A, et al.	2008	USA	Examine the effect of 2 expanded surveillance interventions on MRSA	Reduction in MRSA surgical site infect-ions	Observational, multi-site	3,334 ICU pts, 62035 total hosp-ital pts	Baseline year – only MRSA wound + patients isolated and treated, no routine surveillance, Year 3 Cultures taken on all hospital admission patients, treated with mupirocin if culture positive and contact isolation		PCR3,	
Shrestha, N., et al.	2006	USA	PCR screening protocol	Reduction in Surgical Site infection after cardiac surgery	Retrospective cohort	6,334	Screened prior to surgery with PCR Only carriers/+MRSA nasal culture treated with mupirocin	Convenience Informed consent waived	PCR – no brand	Highly predictive
Tulloch, L.	1954	UK	Comparing phage typing of MRSA intranasal and infected wounds	Common strain of MRSA between intranasal culture and wound	Prospective	73 pairs of cultures	Cultures taken from nares and skin/wound site.	convenience		

APPENDIX D: LITERATURE REVIEW EVALUATION MATRIX

Authors	Year of Publication	Major Strengths	Major Weaknesses	Conclusions	Evidence Level
Carrier, et al.	2002	Very specific, definitions of infections. Interventions outlined – preop screening culture, isolation, preop antibx IV vanco for + MRSA nares cultures, culture results available in 24 hours, mupirocin started preop, strict handwashing with alcohol gel,	Retrospective in nature, Limited to one site Single preop prophylaxis given using vanco only, Preop antibx timing not reported, DM diagnosis not included	13,199 treated patients, 38 surgical patients with MRSA infection. 13 with mediastinitis, 13 with superficial sternal wound infections, 6 leg donor site infections, 51 mediastinal infection with non-MRSA organism. Preventive measures eradicated MRSA infections 1994-1996, an outbreak noted after eradication, preventive measures reinforced with handwashing using alcohol gel added, with low rates observed. No significant difference noted in mortality	2b
Jog, et al.	2008	Observational study Very specific information regarding intervention protocol Assay information provided regarding reliability Infection control policies provided Stats used included Chi-	Limited population in England Additional medication used in intervention – triclosan2%, Different preop IV antibiotics used for prophylaxis – gentamicin and teicoptanin.	Culture done using PCR, nares swabbed preop, mupirocin 2% started preop Rapid PCR screening is effective in identifying nasal colonization with MRSA in preop cardiac surgery patients.	1b

Authors	Year of Publication	Major Strengths	Major Weaknesses	Conclusions	Evidence Level
		square, Koopman's likelihood-based approximation for relative risk. Business model predicted significant savings and was provided – in British pounds	MRSA strains/epidemiology and management differences. Costs of assay in pounds – no exchange rate listed Cost analysis not done, information not provided	Reduction in culture turnaround time significant with PCR vs. traditional culture Number of cases of MRSA was associated with reduction in SSI's but not significant.	
Kallen, et al.	2005	Meta- analysis and review of literature Studies included randomized clinical trials, prospective studies Patients homogeneous	Limited due to number of trials included in review related to inclusion criteria. Trials used were non-randomized. Missed unpublished studies. Baseline usual care differed between studies reviewed	Perioperative intranasal mupirocin appears to decrease the incidence of surgical-site infection when used as prophylaxis in nongeneral surgery. Supports the use of intranasal mupirocin should be considered.	1a
Klevens, et al.	2007	Active, population based surveillance study. 9 sites included in study Use of Active Bacterial Core surveillance/Emerging Infection Program with CDC Case finding were both active and laboratory-based Definitions provided	Results are estimations and could be underestimated. Over-estimation could have occurred in the community surveillance due to MRSA not well documented in medical records. Site under surveillance were urban centers, which	Invasive MRSA affects certain populations disproportionately – obese, diabetics Not contained to ICU, acute care hospitals, or nursing homes. Un-adjusted incidence rates approximately 20-50 per 100,000. Incidence	1b

Authors	Year of Publication	Major Strengths	Major Weaknesses	Conclusions	Evidence Level
			may lead to an overestimation regarding the incidence of MRSA. Mortality was recorded from in hospital deaths thus, deaths could be underestimated. Evaluation of the strains was done in a convenience sample with a small sample used (864)	rates consistently higher in blacks compared with whites. Adjusted incidence rate was 31.8 per 100,000 Health-care associated, community-onset infections were greater than either health care-associated, hospital-onset infections. Incidence rates were highest in people > 65 years of age, blacks, and males. Standardized mortality rate was 6.3 per 100,00 Most common health care risk factors were history of hospitalization, history of surgery, long-term care residence. Most invasive MRSA disease is still caused by MRSA strains of health care origin.	
Nicholson & Huesman	2006	Homogenity with sample population – cardiac surgery patients Prospective study Methods well outlined –	Convenience sample Single site Multiple surgeons Unknown variables, not divided by multiple risk	Carrier rate was reported at 21%. Decrease in Staphylococcus aureus associated SSI observed	2c

Authors	Year of Publication	Major Strengths	Major Weaknesses	Conclusions	Evidence Level
		Nasal cultured before OR, intranasal mupirocin administered and continued Q12hours. Culture results returned in 48 hours. Mupirocin discontinued if culture negative and continued for 7 days if culture positive. PBP2A used for cultured Stats used – t-test and Chi square	factors May have missed readmission, infections from patients being admitted to other facilities.	from a case rate of 1.68% to 0.37% per 100 procedures over 17 month period Positive results were confirmed with PFGE – none of the infections shared the same strain of S aureus either from nasal or wound site Costs to treat premupirocin deep sternal wound estimated to be $470,000. Estimated savings $300,000. Program start up costs estimated at $45,000 including costs of PCR and mupirocin. Prophylaxis antibiotics included cefazolin, vancomycin, cefuroxime.	
Shrestha, et al.	2006	IRB involvement and waiver discussed d/t retrospective design Methods outlined in detail Stat methods used included Large sample size – homogeneous sample Preop antibx administration time included in variables	Retrospective study Did not include ssi at leg harvest site Limited surveillance of wound infection after discharge from facility. Hospitalization length of stay was variable, follow-up timing was variable.	6,334 patients in study Higher carriers in males After changing protocol to discontinue mupirocin if culture negative – no increase in surgical site infections were noted in the early post op period	2b

Authors	Year of Publication	Major Strengths	Major Weaknesses	Conclusions	Evidence Level
			Mupirocin use before hospitalization/surgery was not accounted for,		

APPENDIX E: MUPIROCIN LITERATURE REVIEW CODES AND MATRIX

Code	Patient Population
1	Cardiac surgical
2	Surgical
3	Other
Code	**Care Setting**
1	Multi-sites/multi-hospitals
2	Hospital, multiple wards
3	Hospital, single ward
Code	**Mupirocin Regimen**
1	Pre-operative only
2	On admission to unit
3	Pre and Post-operatively
4	Administered for total doses – 5/7
5	Stopped with negative culture results
Code	**Nasal culture for S. aureus before decolonization**
1	Yes
2	No
Code	**Nasal Culture for S. aureus after decolonization**
1	Yes, no time point specified
2	Yes, 5-7 days after surgery
3	Yes, months after surgery
4	No
5	Not indicated
Code	**Topics Presented**
1	General Cardiac Surgery Principles
2	General Staphylococcus Aureus
3	General Wound Infection Principles
4	Methicillin-Resistant Staphylococcus Aureus
5	Mupirocin – pharmacotherapy principles
6	Mupirocin – prophylaxis
7	Cultures, DNA/PCR

Authors	Year of Publication	Population Discussed	Care Setting	Mupirocin Regimen	Nasal Culture done Preop	Nasal culture done Post	Topics Presented
Banbury, et al.	2003		3	3	1	5	6, 7
Carrier, et al.	2002	1	3	3, 5	1	5	4, 6, 7
Clancy, et al.	2006	3	2	4	1	5	3, 4, 5, 6, 7
Engleman, et al.	2007		1			5	1, 3, 4, 6, 7
Fawley, et al.	2005	3	2	1, 3, 4, 5	1	5	4, 6, 7
Harbarth, et al.	2008	1	3	3	1	5	2,3,5,6,7
Jog	2007	1	3	3, 5	1	2	4, 6, 7
Kallen, et al.	2005	3	1			5	2,4.6.7
Klevens, et al.	2007	3	1			5	4, 7
Kluytmans, et al.	2004	3	1		1		4, 6, 7
Konvalinka, et al.	2006	1	3	3, 5	1	5	4, 6, 7
Laupland & Conly	2003	3	1			5	2,3,5,6,7
Martorell, et al.	2004	1	3	3,5	1	5	4, 6, 7
Mastoraki, et al.	2008	1	3	3, 5	1	5	1, 2, 4, 6, 7
Nicholson, et al.	2006	1	3	3, 5	1	2	4,6 ,7
Parenti, et al.	1987						5
Perl, et al.	2002	3	2		1	5	4, 6, 7
Robicsek, et al.	2008	3	1	6		2	4,7
Shrestha, et al.	2006	1	3	3	1	2	6,7
Streeter, N.	2006						1, 3, 4, 6
Tulloch, L.	1954						7
Ward & Campoli-Richards	1986						5
Weber, et al.	2007						1, 3, 4, 6
Wenzel, & Perl	1995	3					2, 3, 4, 5, 6

APPENDIX F: MUPIROCIN DATA COLLECTION TOOL

Mupirocin Data Collection Tool

Subject #:_____

- MR# and account information stored separately to meet HIPPA guidelines

Demographic Data:

Age: _____ Gender: Male (1) Female (2)

Marital status: Married (1) Widowed (2) Divorced (3) Separated (4) Significant Other (5) Single (6)

Living Situation: With spouse/SO (1) Alone (2) With other family (2) Other (3)

Discharge to: Home (1) Other Family (2) SNF (3) HHC (4) Expired (5)

Past Medical History/Comorbidities:

Diabetes: DM1 (1) DM2 (2) Undiagnosed preop (3)

HTN: (1) Tobacco Use: Yes – Current (1) Yes – recent stopped (2) No (3)

COPD: Yes (1) No (2)

Obesity: BMI > 25 kg/m2 (1) BMI > 30 kg/m2 (2) BMI >35 kg/m2 (3) BMI > 40 mg/k2 (4) Weight _____#, Height _____inches

Laboratory Data Preoperatively:

Serum creatinine: _____ Serum blood glucose: _____ HBGA1C: _____

MRSA/PCR screen done in: PAT (1) Preop (2) Not recorded (3)

Preopmedication:

Steroid use: Home medication (1) Preop only (2)

Mupirocin 2% documented last dose: Yes (1) No (2) Not documented (3)

CHG Shower night before Yes No

CHG Shower in preop Yes No

Preop antibiotic administered at: _____

Preop antibiotic selection: Ancef 1 gm (1) Ancef 2 gm (2) Vancomycin (3) Clindamycin (4)

Antibotic Redose: Ancef 1 gm Ancef 2 gm

Operative Data:

Surgery done: CBG (1) CBG/MVR (2) CBG/AVR (3) MVR (4) AVR (5) CBG/AVR/MVR 6

IMA used: LIMA (1) RIMA (2) BIMA (3)

Core body temp: _____

Blood products received: PRBC (1) # units_____ FFP (2) # units_____

Platelets (3) # units _____ Cryo (4) # units: _____

Cut time/Start time: _____

Postoperative Data:

MRSA/PCR results: Negative (1) Positive (2)

Results documented/posted at: _____

Mupirocin discontinued at: _____

Total doses mupirocin received in hospital: _____

LOS: Admission date: _____ Discharge date:_____-

Surgical Site Infection Data:

Wound infection noted in hospital: Yes (1) No (2)

Wound infection noted after discharge: Yes (1) No (2)

Readmitted for wound infection: Yes (1) No (2)

Organism grown in wound culture: _____

Antibiotic administered: _____

APPENDIX G: UCF IRB

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
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Approval of Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Joanna S. Gerry**

Date: **March 10, 2010**

Dear Researcher:

On 3/10/2010, the IRB approved the following human participant research until 3/9/2011 inclusive:

Type of Review:	UCF Initial Review Submission Form
Project Title:	The Impact of Preoperative Mupirocin Prophylaxis on Surgical Site Infections in Same-day Admission Open Heart Surgery Patients
Investigator:	Joanna S Gerry
IRB Number:	SBE-10-06767
Funding Agency:	
Grant Title:	
Research ID:	n/a

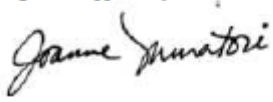
The Continuing Review Application must be submitted 30days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at https://iris.research.ucf.edu .

If continuing review approval is not granted before the expiration date of 3/9/2011, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Joseph Bielitzki, DVM, UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 03/10/2010 04:45:48 PM EST



IRB Coordinator

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