KNOWLEDGE, PERCEPTIONS, AND PRACTICES OF MRSA TRANSMISSION PREVENTION AMONG ACUTE CARE SETTING HEALTHCARE WORKERS

by

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Master of Science
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DEDICATION

This is dedicated to my loving husband Paul who has endured the late nights and endless mounds of paper in our lives. Also, I dedicate this dissertation to my wonderful children and grandchildren who have encouraged and listened to the endless stories of the dissertation tale. To Ema, Ella, Matthew and our future grandchildren who give me hope for the future and a determination to longevity. May God guide you in your lives to accomplish a good work for His purpose.

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First and foremost, I acknowledge my blessed Lord and Savior who placed this challenge before me and gave me the strength to finish. He provided the assurance that the years of classwork and endless hours of study to complete this journey will be used for His purpose. May God bless all those who interceded with prayer for strength and guidance that I might complete this commission for His glory!

I would like to thank my committee for their support and guidance in implementing this research study, their invaluable guidance with the multiple statistical analyses, and of course, the time they dedicated to reviewing and editing the dissertation document.

I must also recognize Karen Speroni, who a great mentor, was instrumental in implementing the research study and the staff at the study facility who enthusiastically gave their time to the research study. Of course, I must recognize family, friends, and classmates for their endless support. Especially I thank Susanne who always took the time to send the card or e-mail for the little nudge of encouragement to pursue to the goal.

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LIST OF ABBREVIATIONS

Analysis of Variance ..... ANOVA
Centers for Disease Control and Prevention ..... CDC
Community Acquired MRSA ..... CA-MRSA
Confidence Interval CI
Contact Precautions ..... CP
Content Validity Index CVI
Hand Hygiene ..... HH
Hand Rub ..... HR
Hand Wash ..... HW
Health Belief Model ..... HBM
Healthcare Worker ..... HCW
Intensive Care Unit ..... ICU
Institutional Review Board ..... IRB
Mean ..... *M*
Methicillin-resistant *Staphylococcus aureus* ..... MRSA
Number of cases in sample ..... *n*
Odds Ratio ..... OR
Question ..... Q.
Research Question ..... R.Q.
Standard Deviation ..... *SD*
Statistical Package for the Social Sciences ..... SPSS
The Joint Commission ..... TJC
Total number of cases ..... *N*
United Kingdom ..... UK
Vancomycin resistant enterococcus ..... VRE
Veterans Administration ..... VA
World Health Organization ..... WHO

ABSTRACT

KNOWLEDGE, PERCEPTIONS, AND PRACTICES OF MRSA TRANSMISSION PREVENTION AMONG ACUTE CARE SETTING HEALTHCARE WORKERS

Dorothy June Mulholland Seibert, Ph.D.

George Mason University, 2013

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The purpose of this research is to explore knowledge, perceptions, and practices concerning MRSA transmission prevention among acute care setting healthcare workers (HCW) and to examine the relationships among knowledge, perceptions, and the demographic characteristics on practice adherence to the Centers for Disease Control and Prevention guidelines to prevent transmission of MRSA.

This mixed-method study utilized three components: 1) survey research on a 33 item validated questionnaire (*N*=276); 2) HCW interviews following a four question interview guide (*N*=26); and 3) direct blinded observations of HCW hand hygiene (*N*=104). Medical, nursing, allied health, and support staff were included.

Survey findings demonstrated high levels HCW's knowledge (98.1%) of precautions but moderated consistency in self-reported practices (gloving = 95.5%, gowning = 89.0%, hand hygiene = 95.1%, with overall adherence = 84.4%). In survey

research, adherence reports were lower when participants observed their peers (gloving = 85.4%, gowning = 76.2%, hand hygiene = 76.7%, with overall adherence = 65.4%). Regarding measures of knowledge while alcohol rubs are the best, only 33.8% of HCW reported thinking that alcohol rubs are the most effective hand hygiene (HH) method. Also, MRSA will live on the surface for days and weeks, only 40.9% were aware of MRSA's viability. HCW group membership and education level were significant predictors for practice adherence ($p<0.015$). Regarding perceptions, HCW's reported comfort with reminding others to gown and glove (85.1%) and to practice hand hygiene (78.8%). In Nursing Staff, self-efficacy, measured by comfort reminding others to gown and glove (Fisher's Exact $p = .03$), and perform HH ($p = .005$) was a moderating predictor of practice. Findings from the blinded HH observations (84.6%) were lower than self-reported HH (95.1%) with Support Staff having the greatest discrepancy. Communication was the most influential barrier (30.2%). Education was the dominant comment provided on the survey (N =85) with an additional 41 comments during interviews. Interview findings demonstrated HCW's positive awareness and responsibility in transmission prevention with minimal barriers.

While HCWs have knowledge regarding guidelines and report practice adherence, they also recognize deficient prevention practices in peers. A gap between knowledge and practices exists. Reported HH adherence is higher than observed HH. Self-efficacy, HCW group, and education are predictor of practice adherence. Education on epidemiological factors supporting practice is recommended to promote hand hygiene adherence

CHAPTER ONE INTRODUCTION

Background and Significance

Healthcare providers are challenged by the continuing emergence of antibiotic resistance as 94,360 invasive methicillin-resistant *Staphylococcus aureus* (MRSA) infections are reported annually in the U.S. (Klevens et al., 2007). One in 20 (5%) of the 368,600 patients treated in U.S. hospitals for MRSA died in 2005 (Elixhauser & Steiner, 2007). In addition to the high mortality rate, the average length of hospital stay for patients with MRSA infection was more than double the average for non-MRSA stays (10.0 days versus 4.6 days) with double the hospitalization cost for MRSA stays at $14,000 versus $7,600 (Elixhauser & Steiner, 2007). Collaborative efforts across healthcare have reduced MRSA healthcare acquired infections by13.4% (Department of Health and Human Services, 2010). Yet, in spite of the overall reduction, the majority, 57.8%, of bloodstream infections caused by *S. aureus* are MRSA infections (Elixhauser, Friedman, & Stranges, 2011; Hidron et al., 2008).

Underpinning the peak of the MRSA epidemic, is the exponential increase of MRSA healthcare acquired infections from 2.4% of *S. aureus* isolates in 1975 to 64% in 2003 (Klevens et al., 2006; Panlilio et al., 1992). Parallel to the rapid increase, community acquired MRSA skin and soft tissue infections became a common cause of hospitalization of children in the U.S. as evidenced by the dramatic increase of

hospitalizations from one case per 100,000 in 1996 to 25.5 cases in 2006 (Frei, Makos, Daniels, & Oramasionwu, 2010). Today the pathogenic methicillin-resistant strain of *S. aureus*, MRSA, continues as a burden primarily related to healthcare, but no longer confined to intensive care units, acute care hospitals, or any healthcare institution (Klevens et al., 2007). True to this fact, the prevalence of community acquired MRSA infections in hospitals is 50% of the total MRSA infections identified in 2010 (Jarvis, Jarvis, & Chinn, 2012).The transition to colonization or infection of even low risk populations places the HCW in a vulnerable position as they provide care to the patient with unsuspected MRSA colonization or infection.

MRSA and healthcare workers. The healthcare worker (HCW) is positioned at the apex of the antimicrobial resistance phenomenon. The HCW stands as the "interface between hospitals, long-term care facilities, and nursing homes on one hand and the community on the other, they may serve as reservoirs, the vector, or the victims of MRSA cross-transmission" in the continued MRSA epidemic (Albrich & Harbarth, 2008, p. 298). Globally MRSA affects the HCW and the patient simultaneously leading to speculation of a symbiotic relationship between the HCW and patient colonization or infection status. Jarvis, Jarvis, and Chin (2012) recently reported their 2010 MRSA prevalence study in acute care identifying an overall MRSA prevalence of 6.64% of all patients hospitalized. In comparison, the rate of MRSA carriage among HCWs is also striking according to historical studies ranging from 0% to 59% with an average MRSA prevalence of 4.6% (Albrich & Harbarth, 2008). Additionally, studies that included hand

cultures in the Albrich and Harbarth review, reported an average 6.4% of HCWs carried MRSA on their hands.

HCW as vector. Poor infection prevention practices by the HCW are often implicated in both acquisition and continued transmission of MRSA. The HCW then becomes the vector in patient to patient, patient to HCW, or HCW to patient transmission of MRSA. Healthcare workers have been associated with transmission of hospital infections attributed to skin and clothing contamination, coughing, sneezing, and skin disease particularly when associated with various risk factors such as increased movement (Ben-David, Mermel, & Parenteau, 2008; Saiman et al., 2003; Sherertz, Bassetti, & Bassetti-Wyss, 2001). Additionally, researchers have provided evidence that MRSA and other resistant bacteria are transmitted by the HCW's hands, clothing, and equipment to the patient, other HCWs, and even family members. Snyder and colleagues (2008) reported 17.5% of HCWs acquired the MRSA or VRE on their gloves, gown, or both after caring for patients colonized or infected with these bacteria. Each HCW must become aware of their role and consequences for nonadherence to practices such as hand hygiene and wearing gowns and gloves to prevent transmission of MRSA.

HCW as victim. The healthcare worker becomes the victim at risk for colonization and subsequent infection as they are subjected to environments with increasing colonization pressure. HCWs in close contact with MRSA colonized or infected patients have increased risk of acquiring MRSA. The nurse is the most vulnerable HCW, with a median of 34 hospital contacts in a 24 hour period (Bernard, Fischer, Mikolajczyk, & Wildner, 2009). In a recently reported study, transmission of *S.*

aureus and MRSA between patients and HCW was identified with the prevalence of HCW MRSA colonization at 9.6% (Elie-Turenne et al., 2010). Although few HCWs have comorbidities placing them at risk for persistent colonization of MRSA, researchers have documented transmission of MRSA between HCW and family members, others in close contact, and pets (Albrich & Harbarth, 2008; Kottler, Middleton, Perry, Weese, & Cohn, 2010; Weese et al., 2006). Additionally, the risk for MRSA acquisition by family or close contacts of MRSA colonized persons may be greater than 50% (Calfee et al., 2003). Most HCWs are unaware of their state of colonization. Neither are they aware of which patients are colonized with MRSA since routine cultures fail to identify 85% of MRSA colonized patients (Salgado & Farr, 2006). Even with highly predictive algorithms, potentially 50% of MRSA colonization may remain unidentified (Morgan et al., 2010). Therefore, not uncommonly, HCWs voice concern for their safety as they return to work to find the patient they cared for the previous day is now isolated for MRSA colonization or infection.

The evidence. There is convincing evidence that improved hand hygiene and adherence to donning personal protective equipment by the HCW through multimodal strategies can reduce transmission of multi-drug resistant bacteria such as MRSA during interactions with infectious patients (Halcomb, Fernandez, Griffiths, Newton, & Hickman, 2008). Hand hygiene nonadherence is associated with significant attributable costs, estimated at $52.53 per non-compliant event (Cummings, Anderson, & Kaye, 2010). Alternatively, researchers have demonstrated cost savings through a sustained decrease of the incidence of multidrug-resistant bacteria infections and patient

colonization following improved hand hygiene adherence (Grayson et al., 2008; Johnson et al., 2005; Lam, Lee, & Lau, 2004; Larson, Early, Cloonan, Sugrue, & Parides, 2000; MacDonald, Dinah, MacKenzie, & Wilson, 2004; Pittet et al., 2000). Failure to perform appropriate hand hygiene is considered the leading cause of healthcare associated infections and spread of multi-resistant organisms. Failure to perform hand hygiene is recognized as a significant contributor to infectious outbreaks (World Health Organization, 2009a).

Guidelines adherence. The decades of insidious encroachment of antimicrobial resistance without definitive guidelines left the healthcare professional in an abyss of misconceptions and indecision of the best practices to prevent the transmission of resistant microorganisms. A number of practitioners in American hospitals felt overwhelmed with the rapid progression of MRSA and perceived MRSA was out of control, and therefore no precautions to prevent transmission were indicated (Farr & Bellingan, 2004; Klevens et al., 2006). Three official publications from the Centers for Disease Control and Prevention (Siegel, Rhinehart, Jackson, Chiarella, & Healthcare Infection Control Practices Advisory Committee, 2006), the Association for Professionals in Infection Control and Epidemiology (2010), and the Society for Healthcare Epidemiology of America (Calfee et al., 2003) now provide the anticipated evidenced based guidelines to focus healthcare workers on reducing transmission of MRSA in the healthcare setting. Additionally, the Institute for Healthcare Improvement (2008) initiated the MRSA component of the "national 5 Million Lives Campaign to improve the quality of American health care by protecting patients from incidents of medical harm."

Contact precautions. The recommended practices to prevent transmission of MRSA include contact precautions, appropriate transportation of the patient, and hand hygiene before and after contact with the patient infected or colonized with MRSA and the patient's environment (Siegel et al., 2006). Contact Precautions are "a set of practices used to prevent transmission of infectious agents that are spread by direct or indirect contact with the patient or the patient's environment. … Healthcare personnel caring for patients on Contact Precautions wear a gown and gloves for all interactions that may involve contact with the patient or potentially contaminated areas in the patient's environment. Donning of gown and gloves upon room entry, removal before exiting the patient's room, and performance of hand hygiene immediately upon exiting are done to contain pathogens" (Siegel et al., 2006, p. 23). Despite these consistent practice recommendations published between 2003 and 2010, researchers reported a historical and current nonadherence to implementation of contact precaution practices with adherence rates ranging from 65% to 77% even after interventional education (Afif, Huor, Brassard, & Loo, 2002; Berhe, Edmond, & Bearman, 2005; Clock, Cohen, Behta, Ross, & Larson, 2010; Cromer et al., 2008; Huskins et al., 2011).

Hand Hygiene. In addition to nonadherence to contact precautions, the HCW's nonadherence to recommended hand hygiene practices continues to be a primary factor of microbial transmission when 48.4% to 82% adherence is observed (Carboneau, Benge, Jaco, & Robinson, 2010; Clock et al., 2010; Huskins et al., 2011). Hand hygiene is a general term for a multi-modal processes to eliminate transient flora on the hands and to reduce resident flora in the pores of the skin. The modes include handwashing with plain

(non-antibacterial) soap and water, antiseptic soap hand wash, antiseptic waterless hand rubs (often containing alcohol), and surgical hand antisepsis performed pre-operatively (Siegel et al., 2006, pp. 49–50). In addition to hand hygiene recommended on exit of the isolation room, the HCW is expected to perform hand hygiene or change gloves as recommended by the CDC in the *Guidelines for Hand Hygiene Practices in Healthcare Setting* (Boyce & Pittet, 2002, p. 32):

- Decontaminate hand before having direct contact with patients.
- Decontaminate hands after contact with a patient's intact skin.
- Decontaminate hands after contact with body fluids or excretions, mucous membranes, non-intact skin, and wound dressings if hands are not visibly soiled.
- Decontaminate hands if moving from a contaminated-body site to a clean-body site during patient care.
- Decontaminate hands after contact with inanimate objects … in the vicinity of the patient.
- Decontaminate hands after removing gloves.

The evidence of epidemiological studies supports the theory that microorganisms are carried from one person to another via hands (Almuneef, Baltimore, Farrel, Reagan-Cirincione, & Dembry, 2001; Duckro, Blom, Lyle, Weinstein, & Hayden, 2005; Muto, Sistrom, & Farr, 2000). Therefore, adherence to hand hygiene and glove and gown use is primary in the care of all patients regardless of their isolation status to prevent transmission of microorganisms, including MRSA (Bhalla et al., 2004).

Education. Corresponding with the publication of guidelines, the CDC sought to identify and institute programs to educate physicians, the healthcare worker, and the public concerning MRSA and to increase the knowledge of MRSA on a national level (Brinsley, Sinkowitz-Cochran, Cardo, & The CDC Campaign to Prevent AR Team, 2004; 2005a; 2005b; Brinsley-Rainisch, Cochran, Bush-Knapp, Pearson, & Get Smart: Know When Antibiotics Work Team, 2006; Bush-Knapp et al., 2007). Shortly after the CDC initiation into action, Congress appropriated to the Agency for Healthcare Research and Quality $5 million to identify and help suppress the spread of MRSA (Elixhauser & Steiner, 2007). And most recently, in August 2011 the Centers for Medicare and Medicaid Services included hospital acquired MRSA bacteremia as a non-payment measurement for the Fiscal Year of 2014 for the hospital inpatient (U.S. Department of Health and Human Services, 2011), again forcing healthcare leaders to identify, and control this costly resistant-bacteria. The additional legislative and The Joint Commission emphasis to educate HCWs and reduce MRSA infections increased focus on acute care hospitals and the HCW's practices (The Joint Commission, 2012). Reflecting on the urgency to increase MRSA awareness and educate healthcare workers, at the current stage of the MRSA epidemic, the knowledge of MRSA and the practices to prevent transmission should be unquestionably at a high level in the U.S. Yet, knowledge levels remain unknown and adherence scores of practices remain less than optimal for effective practice.

Problem Statement

Primary in accurate and efficient implementation of protocols, are the knowledge and perceptions that influence the practices of the HCW and the barriers encountered in practice. The basic knowledge of the epidemiology and transmission of MRSA provides incentive to implement programs, eradicates doubt concerning efficacy, and inspires practice adherence as the HCW understands their risk and their patient's risk for acquisition and transmission of MRSA. The compelling problem that exists is the paucity of current literature relevant to the healthcare worker's knowledge and perceptions and that influence the HCW's practices of protocols critical to interrupt the trajectory of MRSA transmission in the acute healthcare setting. Few researchers have measured the HCW's knowledge, perceptions, and reported practices that reduce transmission of MRSA. The majority of published studies measuring HCW knowledge are ten studies completed in Europe between 2004 and 2009. In the U.S., one interventional study was instituted at 17 Veterans Administration Medical Centers between 2006 and 2007 (Burkitt et al., 2010). Only two smaller scale descriptive studies have also measured knowledge of nursing students and healthcare workers in the (Jennings-Sanders & Jury, 2010; Koltes, 2009). This study assessed the current state of knowledge of the HCW and the perceptions that influence adherence to protocols critical to interrupt the trajectory of MRSA transmission.

Purpose Statement

The purpose of this research study was (1) to examine knowledge, perceptions, and practices concerning MRSA transmission prevention among acute care setting healthcare workers and (2) to examine the relationships among knowledge, perceptions,

and the demographic characteristics on practice adherence to the Centers for Disease Control and Prevention guidelines to prevent transmission of MRSA.

The goal of this research was to provide baseline information for developing an intervention to prevent the transmission of MRSA by healthcare workers in the acute care setting through an assessment of knowledge, perceptions, and practices concerning adherence to MRSA prevention guidelines.

Research Questions

The research questions were:

1. What are the knowledge, perceptions, and self-reported prevention practices of the healthcare worker concerning MRSA transmission prevention in the acute care setting?
2. Do differences exist in the level of MRSA knowledge among the four response groups: Medical Staff, Nurse Staff, Allied Health Professionals, and Support Staff?
3. What demographic variables are best predictive of knowledge concerning MRSA?
4. What are the relationships of knowledge of MRSA and practice adherence to MRSA transmission prevention guidelines?
5. What are the relationships between practice adherence to MRSA transmission prevention guidelines and perceptions:
    a. susceptibility to MRSA infection and practice adherence to MRSA transmission prevention guidelines,

b. severity of MRSA infection and practice adherence to MRSA transmission prevention guidelines,

c. perceived benefit and practice adherence to MRSA transmission prevention guidelines,

d. perceived barriers and practice adherence to MRSA transmission prevention guidelines,

e. self-efficacy to take action and practice adherence to MRSA transmission prevention guidelines, and

f. cues to take action and practice adherence to MRSA transmission prevention guidelines?

6. Among the knowledge, perceptions, and demographic characteristics, which are best predictors of adherence to MRSA transmission prevention guidelines?

7. What are the healthcare workers' preferred resources for information regarding MRSA and infection control and MRSA transmission prevention issues?

8. What are the barriers to the healthcare worker implementing practices adherent to MRSA transmission prevention guidelines?

9. What are the suggestions of ways to prevent transmission of MRSA?

Conceptual Framework

The Health Belief Model (HBM) was the theoretically derived conceptual framework for this study. The HBM was developed in the 1950's by a group of social

psychologists at the U.S. Public Health Service (Janz & Becker, 1984). Studies based on the HBM have been used in planning programs for epidemic diseases, retrospective studies of screening and immunization programs, breast self-examination preventative action, patient adherence, prediction of diabetes self-management, HIV/AIDS intervention in the aging and youth, the habits of everyday living, and problems of addiction.

For example, researchers evaluated the knowledge of a nursing team from a public hospital in the state of Sao Paulo, Brazil concerning preventive measures recommended in the care delivered to patients colonized with MRSA (Silva et al., 2010). Based on the Health Beliefs Model, factors influencing adherence or nonadherence to preventive measures were analyzed. According to the analysis, the nursing team's knowledge and perception of MRSA susceptibility was limited, which indicated the need for actions to improve the understanding of preventive measures employed in the care delivered to patients colonized or infected by this microorganism. Additionally, the HBM continues to be utilized in projects implemented by CDC researchers to plan and assess physician orientated educational programs that focus on the prevention of antimicrobial resistance (Brinsley et al., 2004; Brinsley et al., 2005a; Brinsley et al., 2005b; Brinsley-Rainisch et al., 2006; Bush-Knapp et al., 2007).

The HBM was utilized in this study to capture the relationship of the variables, knowledge, perceptions, and the HCW's self-reported adherence to MRSA prevention guidelines. Self-reported practice is based on explicit knowledge such as policies and guidelines and used to explain intended behavior (Nichols & Badger, 2008). Actual

behavior may be different from intended behavior as seen in reports of higher hand hygiene and gown and glove donning compliance in self-reporting versus actual observation (Shimokura, Weber, Miller, Wurtzel, & Alter, 2006). The HBM considers the likelihood of action when the elements of perceived susceptibility and severity to a health threat are balanced against the benefits and barriers or risk of nonadherence to health recommendations.

Knowledge is gained through experience or association, through education, formal and informal. The HCW gains insight into the factors that predict transmission of microorganisms. When knowledge includes facts relevant to the epidemiology, viability, and transmission of MRSA, the HCW assimilates this knowledge into perceptions of susceptibility and severity. Accordingly, education relevant to reduced infections with implementation of hand hygiene and donning gloves and gowns leads the HCW to perceive the cost benefits, for the patient, himself, and his family.

Perceptions are the "tacit knowledge characterized as subjective, intuitive, and implied without being expressly stated" (Nichols & Badger, 2008, p. 11). The HCW learns new tactic knowledge while working with skilled and experienced practitioners (Nichols & Badger, 2008; Wenger, 2000). However, this tactic knowledge may differ from Infection Prevention policies relevant to the skills and knowledge of the mentor.

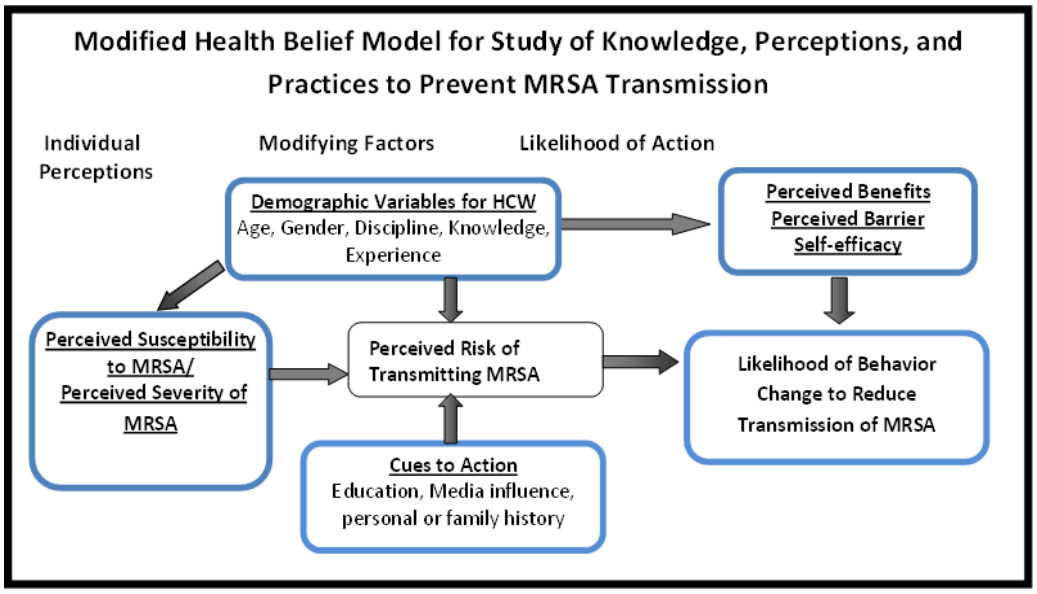

Figure 1. Modified Health Belief Model: Source Stretcher, V., & Rosenstock, I. (1997)

Various early models also included the fifth construct, cues to action. Cues to action are factors or strategies to activate an individual's readiness which triggers and/or instigates an individual's action (Champion & Skinner, 2008). Cues may be bodily events, or environmental events, such as media publicity. Researchers have identified different belief elements primary as action cues suggested to play a role in behavior change, but cues to action have not been systematically studied (Champion & Skinner, 2008). The HBM was utilized to frame the CDC research on the physician's perceptions about antimicrobial resistance and preferred cues to action, or methods to encourage behavior (Brinsley et al., 2005a). The researchers identified that journal articles and scientific evidence were primary cues to action. The cues to action influencing nurses' adherence to Standard Precautions to prevent occupational exposure to microorganisms in Greece included a previous exposure to microorganism, continuous education, and the

influence of their supervisor through role modeling or enforcement of policies (Efstatiou, Papastavrou, Raftopoulos, & Merkouris, 2011). This modified Health Belief Model (Figure 1) to explore risk for transmission of MRSA incorporates similar cues as previous studies; media affect, education/resource preference, and personal or family history of MRSA (Brinsley et al., 2005a; Bush-Knapp, Budnitz, et al., 2007; Efstatiou et al., 2011).

Extended models include the perceived costs of adhering to prescribed intervention as one of the core beliefs. Through the combined variables of cost and benefit, the assessment variable of cost/benefit, the individual weighs the pros and cons to determine whether the new behavior is better than what he is already doing (Hayden & Paterson, 2009). Constructs of mediating factors were later added to connect the various types of perceptions with the predicted health behavior. The demographic variables of gender, age, and occupation may influence perceived seriousness and susceptibility resulting in perceived threat. The H1N1 influenza epidemic of 2009 is an example. The infant and HCW were identified at increased risk for infection and related increased consequences of infection. A threat was perceived as an increased risk for disease consequences or risk for loosing employment, therefore more immunizations were administered than previous years in these populations (CDC, 2010b, 2010c, 2011a; Esolen, Kilheeney, Merkle, & Bothe, 2011; Karanfil, Bahner, Hovatter, & Thomas, 2011).

Additionally, included in this modified HBM are the demographic variables such as work experience, education, and knowledge which influence the individual's perceived seriousness and susceptibility to disease leading to perceived threat. Perceived self-

efficacy was added to the model in 1988 as "one must have confidence in one's ability to take action" (Austin, Ahmad, McNally, & Stewart, 2002; Hayden & Paterson, 2009; Rosenstock, Strecher, & Becker, 1988). Models vary in the adaptation of self-efficacy. As in the HBM illustration used by CDC to assess motivation for physicians to prevent antimicrobial resistance in hospitalized children, this modified version also combines perceived self-efficacy with benefits and barriers to determine likelihood of action (Brinsley et al., 2004).

Conceptual and Operational Definitions

The study examined (1) knowledge, perceptions, and practices concerning MRSA transmission prevention among acute care setting healthcare workers and (2) the relationships among knowledge, perceptions, and the demographic characteristics on practice adherence to the Centers for Disease Control and Prevention guidelines to prevent transmission of MRSA. The study's main variables and their corresponding conceptual and operational definitions are presented in Table 1.

Table 1 Conceptual and Operational Definitions

Variable	Conceptual Definition	Operational Definition
		Dependent Variable
Practice	Strategies and practices to prevent transmission of MRSA (Siegel et al., 2006, p. 4). The application of rules and	Practice adherence is measured by the following three survey questions developed based on existing research related to practices of hand hygiene and wearing gloves and gowns (Burkitt et al., 2010; Koltes, 2009; Trigg, Timmons, & Pynegar, 2008).

	knowledge that leads to action (Badran, 1995).	● Please indicate if you consistently practice the following: 1. Wear gloves when entering a MRSA isolation room. ☐ Yes ☐ No 2. Wear gowns when entering a MRSA isolation room. ☐ Yes ☐ No 3. Perform hand hygiene before and after touching patients? ☐ Yes ☐ No **Measurement**: Nominal. Practice adherence to recommended guidelines is measured by response of "Yes". Non adherence to recommended guidelines is measured by response of "No." A response of "Yes" to all three questions is coded at "Yes" or "adhered". An answer of "No "to any three questions will be coded as "No" or "did not adhere".
		Independent Variable
Knowledge	An individual level of information regarding MRSA (Pittet et al., 2004). The capacity to acquire, retain and use information; a mixture of comprehension, experience, discernment and skill (Badran, 1995).	Knowledge of the healthcare worker concerning MRSA is measured using the five knowledge questions from the Burkitt and colleagues' (2010) research by Veterans' Administration of 2314 HCWs. ● Which of the following precautions should be taken before contact with MRSA patients/items in their room? **Answer:** Hand Cleaning, Gloving, Gowning, ☑**All of the above,** Don't know ● People who have (or carry) MRSA but do not have symptoms can spread MRSA. **Answer:** False, ☑ **True,** Don't know ● How is MRSA most often spread to patients? **Answer:** Overuse of antibiotics, Through the air,

		Bedside equipment, ☑**Health care worker hands,** Don't know ● How long can MRSA live outside the body on surfaces? **Answer:** Seconds, Minutes, Hours, ☑ **Days,** Don't know ● Which hand hygiene method is most effective in killing MRSA? **Answer:** ☑**Alcohol-based hand rub,** Plain soap and water, Antimicrobial soap and water, None of the above Knowledge of community acquired MRSA is measured by this question based on Koltes (2009) survey question on awareness and CDC (2010a), (http://www.cdc.gov/mrsa/definition/index.html) ● Historically, MRSA infections occurred in hospitalized patients (HA-MRSA), but now these infections are common in the community and called community-acquired MRSA (CA-MRSA)? **Answer:** False, ☑ **True**, Don't know **Measurement:** Knowledge is scored from 0 to 6 by adding one point for each correct answer.
		Variables
Perception	Perceptions are the tacit knowledge characterized as subjective, intuitive, and implied without being expressly	Perceptions of MRSA including susceptibility to MRSA infection, severity of MRSA infection, perceived benefit of practice adherence, self-efficacy to take action, and cues to take action are measured using Likert scales 1 to 5 with 1 being strongly disagree and 5 being strongly agree. Self-efficacy in ability to

	stated (Nichols & Badger, 2008).	educate is measured with 1 being very uncomfortable, 5 being very comfortable. Perception of barriers to adherence to recommended practices is measured as a check mark to identify each variable as a barrier.
		Perceived severity of MRSA is measured by the following questions based on existing research (Burkitt et al., 2010): ● MRSA is a national problem. ● MRSA is a problem in this hospital. **Measurement:** Total score 2 -10.
		Perceived susceptibility is measured by the following questions based on existing research (Koltes, 2009; Burkitt et al., 2010): ● I am concerned that I will transmit MRSA to my family and/or friends at home? ● When we are short staffed on my unit, MRSA is spread more than when we are fully staffed. **Measurement:** Total score 2 – 10.
		Perceived benefit is measured by the following two questions based on existing research (Burkitt et al., 2010): ● If I clean my hands, and wear gowns and gloves as recommended, I will decrease my patients' risk of getting MRSA. ● If I clean my hands, and wear gowns and gloves as recommended, I will decrease my risk of getting MRSA. **Measurement:** Total score 2 – 10.
		Perceived barriers are measured by the following question based on existing research (Burkitt et al., 2010; Trigg, Timmons, and Pynegar, 2008): ● What factors do you feel contribute to the transmission of MRSA in your hospital? **Please check ALL that apply.** __Lack of time needed to clean my hands or

		put on gloves and gowns __The alcohol-based hand rub and soap are not easy to reach or find __Communication __Environmental cleanliness __Patient nonadherence to Contact Precautions __My work load **Measurement:** One point per barrier marked. Score total 0 to 6.
	Self-Efficacy: The conviction that one can successfully execute the behavior required to produce the outcome (Bandura, 1977).	Perceived self-efficacy is measured by the following questions based on existing research (Burkitt et al., 2010): ● When healthcare workers on this unit(s) do not clean their hands, I feel comfortable reminding them. ● When healthcare workers on this unit(s) do not gown and glove before touching a patient with MRSA, I feel comfortable reminding them. Perceived self-efficacy is measured by the following question based on existing research (Koltes, 2009) using a Likert scale 1 to 5 with 1 being very uncomfortable, 5 being very comfortable: ●I am comfortable with educating patients and their families about MRSA? (1 being very uncomfortable, 5 being very comfortable) **Measurement:** Total score 3 – 15.
	Cues to action: Strategies to activate readiness to act (Glanz, Rimer, & Viswanath, 2008, p. 48).	Perceived cues to action are measured by the following questions based on existing research (Koltes, 2009; Trigg et al., 2008): ● The news media has influenced my attitude towards MRSA. ● Someone I know had MRSA and the experience influenced my attitude towards MRSA. ● I have received meaningful education regarding MRSA.

		Measurement: Total score 3 – 15
Demographic information	Individual characteristics that identify participants into groups	**Characteristic:** Demographic characteristics are measured by the following questions based on existing research (Burkitt et al., 2010):
		1. Confirm you have direct contact with patients or enter patient areas? □Yes If you do not enter patient areas or have direct contact, do not continue. 2. Observations: Hand Hygiene Adherence □Physician Assistant □Nurse Practitioner □Registered Nurse □Certified Nursing Assistant/Technician □Licensed Practical Nurse □Other nursing staff □Social Services □Cardio-Pulmonary □Laboratory □Medical Imaging □Pharmacist/Pharmacy □Physical Therapy □Speech Therapy □Occupational Therapy □Food Services □Engineering and Security □Environmental Services □Patient Registration □Other (Specify)_____ 6. Total Years in current Health Care Profession (include other hospitals): _____ 7. Hours worked per week at this hospital status? □Full-Time □Part-time □PRN
Other	**Descriptive**	**Variable**
	The descriptive variables identify perceptions of the participant related to MRSA transmission prevention practices of other staff members and the most influential perceived barrier to implementing practice.	The perception of other HCW's adherence to MRSA transmission practices are measure by the following question based on existing research (Burkitt et al., 2010; Trigg et al., 2008; Koltes, 2009): ● Please indicate if **other staff members consistently** practice the following: 1. Wear **gloves** when entering a MRSA isolation room. ☐ Yes ☐ No 2. Wear **gowns** when entering a MRSA isolation room. ☐ Yes ☐ No 3. Perform **hand hygiene** before and after

		touching patients? ☐ Yes ☐ No **Measurement:** Nominal. Descriptive statistics; percentages. Practice adherence to recommended guidelines is measured by response of "Yes". Non adherence to recommended guidelines is measured by response of "No." Practice will be scored one point per "Yes" and 0 for "No". Total scores 0 to 3.
		Most influential barrier is measured by the following question based on existing research (Burkitt et al., 2010; Trigg et al., 2008): ● From question 28, which factor do you consider being the MOST influential in the risk of MRSA transmission in your hospital? **Please check ONE box only.** __Lack of time needed to clean my hands or put on gloves and gowns __The alcohol-based hand rub and soap are not easy to reach or find __Communication __Environmental cleanliness __Patient nonadherence with Contact Precautions __My work load **Measurement**: Descriptive statistics; percentages
Structured Questions:	Structured data collection involves constraints so there is consistency in the questions asked and how the answers are reported (Polit & Beck, 2008, p. 414).	Question on barriers adapted from previous research to provide a richer and broader understanding of the participants perspective on barriers to adherence to MRSA transmission prevention practices and unidentified transmission modalities (Burkitt et al., 2010)
		● Please provide suggestions of ways to prevent transmission of MRSA: _____

		Measurement: Descriptive statistics. Content analysis.
		● Please suggest other barriers that prevent implementing isolation precautions or appropriate hand hygiene:_____ **Measurement**: Descriptive statistics. Content analysis.
Preferred Resources	Individual preferences for information regarding MRSA and infection control/prevention issues	Preferred Resources are measured by the following question based on existing research (Trigg et al., 2008; and Koltes, 2009): ● Please indicate your preferred resources for information regarding MRSA and infection control/prevention issues. Infection Prevention Nurse ☐ Yes ☐ No Infection Control Manual ☐ Yes ☐ No Manager ☐ Yes ☐ No Colleagues ☐ Yes ☐ No Internet ☐ Yes ☐ No Do my own search ☐ Yes ☐ No **Measurement**: Descriptive statistics; percentages.
Preferred Educational format or presentation	Individual preferences for receiving information regarding MRSA and infection control/prevention issues.	Preference for receiving information are measured by the following question based on existing research (Paterson, 2010): ● Please indicate how you prefer to receive information on MRSA: Please check ALL that apply. Class Room Presentation ☐ Yes ☐ No E-mail communication ☐ Yes ☐ No Link to Web site ☐ Yes ☐ No Information Flyers ☐ Yes ☐ No Staff meeting talks ☐ Yes ☐ No Other_____ **Measurement**: Descriptive statistics; percentages.

Summary

Healthcare workers stand at the forefront of healthcare in our hospitals, long-term care facilities, nursing homes, and the community. They may serve as source, vector, casualty, or the catalyst to break the chain of events that propagate continued microbial resistance. There is convincing evidence that improved hand hygiene and adherence with donning personal protective equipment through multimodal implementation strategies can reduce transmission of multi-drug resistant bacteria such as MRSA. Yet, despite education on prevention of transmission of microorganisms, HCWs continue to be the primary transmission factor with nonadherence to MRSA prevention guidelines. The compelling problem that exists is a gap in current literature relevant to the healthcare workers' knowledge, perceptions, and practices critical to interrupt the trajectory of MRSA transmission in the acute healthcare setting in the U.S. Therefore, the purposes of this research are (1) to examine knowledge, perceptions, and prevention practices concerning MRSA transmission among acute care setting healthcare workers and (2) to examine the relationships of knowledge, perceptions, and the demographic characteristics on practice adherence to the Centers for Disease Control and Prevention guidelines to prevent transmission of MRSA.

CHAPTER TWO REVIEW OF THE LITERATURE

A literature search was conducted to identify research that (1) measures the HCW's knowledge and perceptions of MRSA and/or (2) reports the HCW's adherence to contact precautions and hand hygiene to prevent transmission of MRSA in the acute care setting. In January 2012, a search was conducted of databases representing a variety of health-related disciplines databases including: the Cumulative Index to Nursing and Allied Health Literature (CINALH), Medline, Health Source: Nursing/Academic Edition, and Global Health. The databases were searched simultaneously for peer reviewed publications in English between January 2000 and January 2013, using the terms "Methicillin-Resistant *Staphylococcus aureus*" AND ("Knowledge," "Nurses," "Physicians," "Perception," and/or "Attitude"). A total of 131 articles were identified. Of these, 20 articles were relevant to the acute care HCW's knowledge and perceptions of MRSA. The second search to identify HCW adherence to contact precautions and hand hygiene included the terms "Methicillin-Resistant *Staphylococcus aureus*" AND ("Compliance," "Health Knowledge, Attitudes, Practice," "Hand Washing," and/or "Hospitals"). Of the 75 articles on contact precautions, 27 were retained; of the 217 hand hygiene articles, 56 were retained.

The 20 studies assessing the HCW knowledge and perceptions of MRSA are an international mix with a variety of aims, purposes, and populations. Nine studies were

completed in the United Kingdom, one in the Netherlands, and two in Brazil. The CDC conducted two studies focusing on physician motivation to prevent antimicrobial resistance (AMR) and hospitalist's knowledge and perceptions of health-care associated infections and AMR (Brinsley et al., 2004; Bush-Knapp, Brinsley-Rainisch, et al., 2007). More recent studies in the U.S. include a 2010 interventional study by Burkitt and colleagues assessing the knowledge and attitudes concerning MRSA among 952 staff members in 17 Veterans' Administration (VA) healthcare facilities. Jennings-Sanders and Jury (2010) assessed MRSA knowledge among 119 nursing students in Cleveland, Ohio. Additionally, Koltes (2009) assessed the attitudes, understandings, and perceived risk of MRSA among HCWs in North Dakota. Of the ten audit or survey assessment studies evaluating HCW knowledge, seven questionnaires included policy, practice, or treatment questions pertinent to their healthcare facility or national protocols. These specific questions may not be considered appropriate for all HCWs. However, many questions are within the expected norm of all HCWs, such as a question on the effectiveness of alcohol hand cleaning products. Three studies, including Burkitt and colleagues (2010); Trigg, Timmons, and Pynegar (2008); and Koltes (2009), present a knowledge, attitude, and practice assessment of MRSA suitable across the spectrum of healthcare worker disciplines internationally.

The compelling problem that exists is the paucity of current literature assessing the HCW's knowledge and perceptions of MRSA in relationship to hand hygiene and contact precaution practices in the U.S. Researchers estimate the prevalence of MRSA in acute care hospitals range from 6.6% to 7.3% of patients admitted (Hidron et al., 2005;

Jarvis et al., 2012). Although the rates of infections reported to the CDC national database are decreasing, the portion of *S. aureus* resistant to MRSA in the infections reported continues to rise. Therefore, this review presented literature to establish the relationship between adherence to practice guidelines and reduction of MRSA. Following the practice review, inter-variable relationships were explored, concluding with barriers identified that inhibit adherence to MRSA transmission prevention practices.

Practice: Contact precautions

In today's era of rapidly progressive antimicrobial resistance, the healthcare worker is scrutinized for compliance with contact precautions (CP). As stated in the CDC's guidelines, *Management of Multidrug-Resistant Organisms in Healthcare Settings, 2006,* the HCW caring for patients on CP should wear a gown and gloves for all interactions that may involve contact with the patient or potentially contaminated areas in the patient's environment. Donning gown and gloves upon room entry and discarding them before exiting the patient room contains pathogens, especially those that have been implicated in transmission through environmental contamination (Siegel et al., 2006). Adherence to these guidelines will protect the HCW and prevent transmission of potential pathogens from the patient room.

Researchers have confirmed MRSA and other multiple resistant bacteria are transmitted from patients to the gloves, gowns, and hands of the HCW. Snyder and colleagues (2008) assessed the rate of and the risk factors for the detection of MRSA on the protective gowns and gloves of healthcare workers. Culture samples were obtained from 137 HCWs' hands prior to entering a patient's room and from HCWs' gowns and

gloves after completing patient care activities. After caring for patients , 17.5% of the HCWs acquired MRSA and/or VRE on their gloves, gown, or both (Snyder et al., 2008). McBryde, Bradley, Whitby, and McElwain (2004) identified that approximately 17% of contacts between a HCW and MRSA-colonized patient result in transmission of MRSA to the gloves. Therefore, adherence to recommended practices of gowning, gloving, and hand hygiene is essential to prevent transmission of MRSA and other multi-resistant organism.

Several researchers have directly observed HCWs providing patient care while in rooms under CP. Huskins and colleagues (2011) followed 5434 admissions to ten ICUs in the U.S. post education. Observed adherence to practice protocols in these ICUs was 82% for gloves, 77% for gowns, and 69% for hand hygiene after patient contact. Surveillance conducted in three New York City hospitals by Clock, Cohen, Behta, Ross, and Larson (2010) identified similar adherence rates. The overall adherence to precautions by 1062 people observed on room entry and exit, 3397 observations, was 19.4% for hand hygiene, 67.5% for gloves, and 67.9% for gowns on room entry, and 48.4% for hand hygiene on room exit. In another prospective observational study in a 900 bed mid-west teaching hospital, researchers observed a 73% compliance with gown use for 1542 HCWs and visitors (Manian & Ponzillo, 2007). These observations support the conclusions that protective equipment adherence in CP is less than optimal for prevention of pathogen transmission.

Researchers suggest there are correlations between adherence with gown or glove utilization and adherence to hand hygiene protocols. Clock and colleagues (2010)

concluded the HCW's adherence with gloving or gowning was predictive of additional preventative behaviors, hand hygiene, gloving, or gowning, $p < .001$. After observing hand hygiene adherence was higher during universal gloving than when utilizing CP for MRSA, $P = .001$, Bearman and colleagues (2010) surmised that glove use may promote increased hand hygiene compliance. An observational study of hand hygiene and glove adherence in two ICUs at a tertiary care hospital also found a statistically significant, positive association, $P < .001$, between glove use and subsequent hand disinfection suggesting a relationship (Kim, Roghmann, Perencevich, & Harris, 2003). In contrast, a research team in the U.S. found no difference between hand hygiene adherence in 851 opportunities among HCWs entering ICU rooms with CP and those without (Gilbert, Stafford, Crosby, Fleming, & Gaynes, 2010).

Practice: Hand hygiene

Appropriate hand hygiene at the appropriate time will break the chain of transmission and provide a safer environment for all susceptible hosts: the patient, HCW, and visitors. Despite education on prevention of microorganism transmission, the HCW's noncompliance in hand hygiene continues to be a primary factor for microbial transmission (Boyce & Pittet, 2002; E. Larson et al., 2000). At the turn of the century baseline compliance was recorded at 48% (Pittet et al., 2000), 60% (Muto et al., 2000), 36% (Stéphane Hugonnet, Perneger, & Pittet, 2002), and 33% (Harbarth et al., 2002) by global researchers. Later higher compliance rates were observed after interventions or creating cues to action; for example a rate of 69% with the introduction of alcohol-based hand rubs (Rupp et al., 2008), 79% in all wards after a multimodal intervention (Ebnöther

et al., 2008), 62% after introduction of personal handrub dispensers (Janet P Haas & Larson, 2008), 70.1% with voice prompts (Venkatesh et al., 2008), and 82% by applying a Lean Six Sigma Team approach of eliminating barriers (Carboneau et al., 2010).

Hand hygiene studies prior to 2010 point to a median compliance rate of 40% with lower rates reported in ICU, 30%-40%, than in other settings, 50%-60% (Vicki Erasmus et al., 2010). Lower compliance rates were generally those with a high activity level and/or those in which a physician was involved (Didier, 2001; Didier et al., 2000). In studies incorporating before and after patient contact observations, large differences were identified between the aggregated 21% before and 47% after patient contact hand hygiene adherence rates (Erasmus et al., 2010). Korniewiccz and El-Masri (2010) similarly reported lower HCW hand hygiene adherence prior to procedures than post procedure during routine clinical events. The researchers reported adherence of 41.7% (*n* = 255) before procedure and 72.1% (*n* = 441) after, suggesting the HCW is more likely to perform hand hygiene "to protect themselves more than their patients". Supporting this theory, Mertz, Dafoe, Walter, Brazil, and Loeb (2010) reported significantly lower adherence before care or pre-insertion of intravenous catheters, when preventing infection in the patient is primary. Situations considered "dirty tasks" such as wound contact appear also to be associated with higher hand hygiene compliance rates (Erasmus et al., 2009; Mertz et al., 2010). Before wound contact the intervention group completed 5.3% (*n* = 19) hand hygiene opportunities, but post wound contact adherence to hand hygiene was 77.2% (*n* = 57) opportunities, supporting the theory of self-protection (Mertz et al., 2010).

Practice: MRSA transmission prevention

Reduction of MRSA incidence, prevalence, and rates is the primary purpose of many interventional and comparative studies. There is some evidence that reduced MRSA transmission can be achieved by improving compliance with CP alone (Halcomb, Griffiths, & Fernandez, 2008). Cromer and colleagues' (2004) multimodal intervention that included feedback and accountability related to contact precaution compliance resulted in a 30% reduction of facility-acquired MRSA. As compliance rates improved from 19% to 71.5%, the MRSA rate decreased from 69/100,000 to 48/100,000 patient days over two years despite increased MRSA risk. Cheng and colleagues (2010) compared MRSA infection acquisition rates with those of other resistant bacteria at baseline, after an ICU renovation, and after implementation of alcohol-based hand hygiene. A significant reduction in ICU onset MRSA infections was observed from phase one to phase three, 3.54 to 1.02 per 1000-patient-days for nonbacteraemic, and 1.94 to 0.28 per 1000-patient-days for bacteraemic infections. Several studies have reported a significantly increased adherence to hand hygiene practices or consumption of alcohol hand rubs with reductions of MRSA cases from 36% to 67% (Christiaens et al., 2006; Cromer et al., 2008; Eveillard et al., 2006; Girou, Loyeau, Legrand, Oppein, & Brun-Buisson, 2002; Grayson et al., 2008; Harrington et al., 2007). Additionally, Carboneau and colleagues (2010) reported a significant increase in hand hygiene adherence, 65% to 82% through implementation of a Lean Six Sigma Team approach resulting in a 51% decrease in MRSA acquired infections and an estimated savings of US $276,500 through the reduction of infections. Alternatively, other researchers have concluded that

education, surveillance, and CP for colonization or infection were not effective in reducing the transmission of MRSA or VRE (Huskins et al., 2011). However, the study results indicated unsatisfactory adherence to contact precaution protocols or universal gloving in control ICUs, possibly a contributing factor in no reduction in MRSA rates. The evidence linking hand hygiene interventions and healthcare acquired infections is present, but it is not well quantified due to the varied nature of the interventions and "the diverse factors affecting the acquisition of healthcare acquired infections that make it difficult to show the specific effect of hand hygiene alone" (Backman, Zoutman, & Marck, 2008, p. 333).

Knowledge and MRSA

As multiple interventions are implemented to reduce MRSA infections, the HCW is positioned as the catalyst to implement evidence based practices. Evaluating the influence of these interventions on the employee's knowledge and perceptions can provide valuable information on potential mechanisms of change and the effectiveness of continual MRSA prevention initiatives (Burkitt et al., 2010). Various assessments of the HCW's knowledge indicate multiple levels relevant to the knowledge assessed. Researchers in the Netherlands reported 87% of the 63 HCWs had an overall knowledge of preventative measures; however, in observed scenarios only 45% were able to determine tasks to prevent MRSA transmission (van Gemert-Pijnen, Hendrix, van der Palen, & Schellens, 2005). Respondents in two studies, one in the U.S. and one in the U.K., rated their knowledge of MRSA on a scale of one to ten (1 = no knowledge and 10 = expert knowledge) as above five and their colleague's knowledge slightly higher

(Koltes, 2009; Trigg et al., 2008). Burkitt and colleagues (2010) reported a small increase post intervention in the mean number of knowledge questions answered correctly from baseline to follow-up, 3.52 to 3.64 of five, with a corresponding significant increase in the proportion of respondents correctly answering all five knowledge questions, 9% to 17%.

Knowledge Question 1: Precautions for MRSA. The majority of studies in Europe support a high level of knowledge and self-report compliance with contact precautions ranging from 65.5% in Iran to 95% in U.K. (Askarian, Aramesh, & Palenik, 2006; Askarian, Shiraly, Aramesh, & McLaws, 2006; Askarian, Shiraly, & McLaws, 2005; Easton et al., 2007; Trigg et al., 2008; van Gemert-Pijnen et al., 2005). In the U.S., Burkitt and colleagues (2010) report indicated physicians (n = 68) scored the lowest (90.7%) in knowing that hand hygiene, gloving, and gowning are required before contact with the MRSA patient or items in the room. Respondents to Koltes' (2009) survey exhibit excellent knowledge of precautions to prevent transmission of MRSA with 99% selecting gloves, 94% selecting gowns, and 96% indicating hand hygiene. However, 80% of the 225 respondents stated they applied CP consistently, but only 52% felt that their colleagues consistently applied CP. When asked, 60% of respondents chose compliance of staff as the most influential factor in the risk of cross-infection. These studies support the theory that HCWs have an adequate knowledge of contact precaution practices and they perceive the benefit of precautions, but may not be consistent in implementing appropriate practice.

Knowledge Question 2: Transmission without Symptoms. The major contamination source in the healthcare facility may be the invisible MRSA colonization state of the patient where potentially 50% of MRSA colonization may remain unidentified (Morgan et al., 2010). Colonization is when a person carries the organism, but shows no clinical signs or symptoms of infection with the nose being the most common body site colonized (CDC, 2010a). In the U.K. inconsistent knowledge is evident in the studies: 64.2% of nurses knew the meaning of colonization (Lugg & Ahmed, 2008); 70% of 188 physicians knew the primary colonization site is the nose (Brady, McDermott, Cameron, Graham, & Gibb, 2009); but knowledge of appropriate cultures sites to detect MRSA colonization was low, 30% of physicians and 36% of nurses (Easton et al., 2007). In the US, 98.4% of physicians and 95.9% of nurses answered correctly, that people who have MRSA, but do not have symptoms can spread MRSA (Burkitt et al., 2010). In this survey the HCW group with the lowest score is the support staff with a score of 89.5% post education. Cruz, Pimenta, Hayashida, Eidt, and Gir (2011) reported only12.7% of 63 environmental services staff in Brazil indicated knowledge of MRSA and CP. Of this group 20.6% were MRSA culture positive. Knowledge of MRSA colonization appears to have a tiered effect parallel to education with physicians and nurses having more understanding of colonization than other HCWs.

Knowledge Question 3: Transmission by Hands. Research utilizing hand imprints onto agar plates before and after contamination provides evidence that HCWs transmit microorganisms from the patient or environment to the next person or object touched by their hands, with or without gloves (Stiefel et al., 2011). Testing of sterile

gloved hands before and after touching patients positive for MRSA and room surfaces identified that hand contamination was equally likely from skin sites (40%) or environment (40%) around MRSA patients (Stiefel et al., 2011). Consequently with repeated exposure to microorganisms, the hands of HCWs may become persistently colonized with pathogenic flora such as *S. aureus* (Boyce & Pittet, 2002). Evidence exists that not only the HCW is at risk for colonization, but that 90% of carriers of *S. aureus* will also carry the bacteria on their hands causing environmental contamination (Dancer, 2008; Rohr et al., 2009; Wertheim et al., 2005). Three studies directly asked the question "How is MRSA most often spread?" Trigg and colleagues (2008) from the UK received the highest percentage correct with 91% of participants relating hand contact as the main route of MRSA spread. Burkitt and colleagues (2010) reported an overall 85.5% correct responses with physicians (92.0% post intervention) and Allied Health group (91.1% post intervention) having the highest scores. Koltes (2009) reported 81% of the respondents identified contact via hand transmission when asked to identify the main route of the spread of MRSA. The researchers in these studies have endorsed that HCWs have a good understanding of MRSA spread primarily by hands, but the 14.6% of the participants in the VA survey (Burkitt et al., 2010) and the 19% in Koltes' (2009) study who did not understand the importance of hand transmission open a wide potential for cross-contamination in our healthcare system.

Knowledge Question 4: Bacteria survival. Researchers have identified that staphylococcus and enterococcus survive for days to months after drying on commonly used hospital fabrics and plastic (Neely & Maley, 2000; Wagenvoort, Sluijsmans, &

Penders, 2000). Additionally, MRSA was demonstrated to survive on sterile goods packaging for more than 38 weeks (Dietze, Rath, Wendt, & Martiny, 2001). Two studies questioned the HCW knowledge of environmental survival of MRSA. Of the 811respondents in the VA survey by Burkitt and colleagues (2010), 59% answered correctly post education that MRSA survives for days to the question: "How long can MRSA live outside the body on surfaces." Jennings-Sanders & Jury (2010) reported excellent scores of 91-95% by nursing students on knowing that MRSA can survive on surfaces hours, days, and months.

Knowledge Question 5: Hand Hygiene. The microbiological efficiency of alcohol-based hand disinfectants has been demonstrated in vitro in reducing the bacterial count on artificially contaminated hands (Lucet et al., 2002). The World Health Organization (WHO) recommends alcohol-based handrubs for hand hygiene stating: "according to scientific evidence arising from efficacy and cost–effectiveness, alcohol-based handrubs are currently considered the gold standard approach" (WHO, 2009). The CDC hand hygiene guidelines (Boyce & Pittet, 2002, p. 32) recommend, if hands are not visibly soiled, use of an alcohol-based hand rub for routinely decontaminating … (IA strongly recommend with supporting studies). As stated by Larson, Eke, and Laughon (1986, p. 544) "For some time, alcohol-based hand washing products have been successfully used in Europe…, but have come into some disfavor and disuse in the United States." In the UK researchers reported 62% to 66% physicians and 96% of medical students agreed alcohol gel is as effective as handwashing in reducing MRSA (Brady et al., 2009; Seaton & Montazeri, 2006). However, in the U.S., when asked the

question, "Which hand hygiene method is most effective in killing MRSA?" HCWs correctly replied the alcohol-based hand rub for a statistically significant difference (p = .001) with 20.2% pre-intervention and 31.1% post-intervention (Burkitt et al., 2010). The physician group (37.3% correct) and the nurses (36.7% correct) scored the highest correct answers post-intervention.

Knowledge Question 6: CA-MRSA. Methicillin-resistant *Staphylococcus aureus*, usually known as a healthcare acquired pathogen, has emerged as the predominate cause of skin and soft-tissue infections in many communities (Hidron, Low, Honig, & Blumberg, 2009). These community acquired MRSA (CA-MRSA) strains seem to be particularly virulent with overwhelming tissue destruction causing necrotizing fasciitis and necrotizing pneumonia (Chambers & DeLeo, 2009; Frei et al., 2010; Hidron et al., 2009). CA-MRSA is now a common cause for hospitalization of children with skin and soft tissue infections in U.S. with rates of admission rising from less than one case per 100,000 U.S. children in 1996 to 25.5 cases per 100,000 in 2006 (Frei et al., 2010). One study questioned the HCW concerning familiarity with the term "community acquired MRSA", reporting 88% of 225 respondents indicated familiarity with this term for MRSA (Koltes, 2009).

Perception of Severity of MRSA

Healthcare workers recognize the severity, morbidity, and mortality associated with MRSA infections, whether originating in the hospital or the community. Four nationally distributed focus groups of physicians who treat hospitalized children perceived the MRSA problem as serious in the U.S. (92%), in their hospital (76%), and in

(60%) their practice (Brinsley et al., 2005a). The Veterans' Administration reported 90.4% of their HCWs perceive MRSA as a national problem post intervention (Burkitt et al., 2010). In the same group 65.0% overall perceive MRSA is a problem in their unit post intervention. Of the respondents to Kolte's (2009) survey 93% believed MRSA was found throughout the hospital. Although, perception of presence in the hospital or working unit did not influence practice, the respondents who believed that MRSA was either a very serious or a serious issue (95%) were significantly more likely to report that they were consistent with infection control precautions (Koltes, 2009). Sax, Uçkay, Richet, Allegranzi, and Pittet (2007) reported the HCW's perception that healthcare-associated infections are severe for patients was highly ranked as a determinant of behavior by 32.1% of the 1042 respondents.

Perception of Susceptibility to MRSA

Transmission to family. The HCW may perceive they are susceptible to acquiring and transmitting MRSA to their family. Researchers have documented incidents of HCW carriage of MRSA colonization or infection with an estimated prevalence of MRSA carriage of 4.7% in HCW in ICU and 6.3% in the general ward globally, and 4.2% (328 MRSA in 7886 tested) in North America (Albrich & Harbarth, 2008). The role of the HCW as the vector in transmission of MRSA to patients and family members is documented in literature (Albrich & Harbarth, 2008; Ben-David et al., 2008; Calfee et al., 2003; Kaminski, Kammler, Wick, Muhr, & Kutscha-Lissberg, 2007; Sherertz et al., 2001; Vonberg et al., 2006). In France researchers reported HCW prevalence of MRSA as 6.2% in 965 hospital workers. The investigation included ten

families with transmission identified in six (28.6%) of the 21 family members screened (Eveillard, Martin, Hidri, Boussougant, & Joly-Guillou, 2004). Internationally 47% to 92.7% of HCWs feel at risk as they "examine patients" and are "in contact with infected patients" providing care (Da Silva et al., 2010; Gill, Kumar, Todd, & Wiskin, 2006; van Gemert-Pijnen et al., 2005). In Hong Kong, Cheng and colleagues (2010, p. 1) reported a significant reduction in MRSA infections in comparison of rates before and after the severe acute respiratory syndrome (SARS) epidemic. The researchers "suggest that the deaths of fellow healthcare workers from an occupationally acquired infection had an overwhelming effect on their compliance with infection control measures." Additionally, HCWs voice concern for their family as a focus group participant in Canada stated: "You're trying to protect yourself from bringing anything home especially if you have little ones" (Jang et al., 2010, p. 146). In the U.S., 53% of the 225 HCW indicated concern about contracting an MRSA infection and 42% feared transmitting MRSA to family or friends (Koltes, 2009). Although, worry about contracting a MRSA infection and fear of transmitting MRSA to family and friends at home were not significantly correlated with self-reported compliance, the belief of non-colonization had a significant correlation to self-reported compliance ($p < .0001$) with prevention protocols.

Short staffed. Many HCWs in the VA system perceive that staffing shortages contribute to MRSA transmission; 39.8% respondents agreed that staff shortages contribute to MRSA transmission, with the highest groups being 41.7% of physicians and 46.2% of nurses (Burkitt et al., 2010). Research supports the theory that staffing variables are a key determinant of healthcare-associated infection in critically ill patients (Cimiotti,

Aiken, Sloane, & Wu, 2012; S Hugonnet, Chevrolet, & Pittet, 2007; Stéphane Hugonnet, Uçkay, & Pittet, 2007; Sujijantararat, Booth, & Davis, 2005; Weinstein, Stone, Pogorzelska, Kunches, & Hirschhorn, 2008). Hugonnet, Chevrolet, and Pittet (2007) followed 1,883 patients over four years and concluded that staffing is a key determinant of healthcare-associated infection in critically ill patients. Controlling for device variables, a higher staffing level was associated with a >30% infection risk reduction. A recent study of staffing utilizing the Agency for Healthcare Research and Quality risk-adjusted safety and quality indicators for 872 adult inpatient units in the U.S. supports an association (Blegen, Goode, Spetz, Vaughn, & Park, 2011). The researchers reported that higher total hours per day of nursing care in general units and ICU were significantly associated with lower rates of infections. Additionally, in the ICU higher RN skill mix was associated with fewer cases of sepsis.

Self-efficacy

Self-efficacy is the "conviction that one can successfully execute the behavior required to produce the outcome (Bandura, 1977, p. 193; Janz & Becker, 1984, p. 44). Outcomes for self-efficacy have been measured not only in one's ability to overcome barriers, but also "increase confidence that participant can encourage" others to perform the anticipated outcome (Champion & Skinner, 2008, p. 55). As related to hand hygiene, "adherence is driven by peer pressure and the perception of high self-efficacy, rather than by reasoning about the impact of hand hygiene on patient safety" (Sax et al., 2007, p. 1267). One study where respondents self-reported 100% adherence to practice, 85% of them also reported comfort reminding staff and visitors who are neglecting the protective

equipment and hand hygiene (van Gemert-Pijnen et al., 2005). Respondents to the VA survey reported increased comfort in reminding other staff about proper hand hygiene (from 61% to 72%, $P < .001$) and CP (from 63% to 70.3, $P < .002$) after education (Burkitt et al., 2010). In contrast, without the educational intervention, respondents in Koltes' (2009) survey also indicated an overall low comfort level in educating patients and their families about MRSA with a mean comfort level of 5.1 on a scale from one to ten. Behavioral theory model testing completed by De Wandel, Maes, Labeaus, Vereecken, and Blot (2010) suggests low self-efficacy is independently associated with noncompliance, $\beta = .379$; $P = .001$. Therefore, the HCW with low confidence will most likely have lower adherence to hand hygiene and CP.

Cues to action

The fifth construct of the Health Belief Model (HBM) is the cues to action or what factors are the HCW exposed to that will prompt action. Previous HBM analysis by the CDC utilized the physician's preferences of methods to learn about antimicrobial resistance as the cue to action (Brinsley et al., 2005a). The historical HBM presented by Janz and Becker (1984, p. 4) indicates "mass media campaigns, advice from others, reminder postcards, illness of family member or friend, and newspaper or magazine article" are possible cues (Becker et al., 1977). Examples related to infection prevention may include personal experience, reminders at the workplace, easy access to hand hygiene agent, and institutional promotion programs (Pittet, 2004).

Media. Gill and colleagues (2006) from the U.K. reported the general media was the most common source for information about MRSA for 68% of 50 hospital

patients/visitors with 42% indicating television and 26% indicating newspapers. In comparison, 24% of 100 HCWs selected the general media, $P < .01$. Also in the U.K., Trigg and colleagues (2008) reported 44% of 411 staff audited felt media attention towards MRSA had influenced their attitude. In comparison, in the U.S. 75% of respondents indicated they were not influenced by media attention on MRSA (Koltes, 2009).

Personal experience. There are a paucity of studies exploring the relationship of a personal experience with MRSA and adherence to hand hygiene and contact precautions. A previous exposure was reported as a cue to action in a focus group study of factors that influence nurses' compliance with Standard Precautions (Efstatiou et al., 2011, p. 7). The groups agreed that being exposed to a microorganism was a devastating experience. "The psychological impact can be high (anxiety, depression) both for the nurse and his/her family." Alternatively in respondents "who reported that either they themselves personally had MRSA or someone in their family had MRSA in the past were not more likely to report that they were consistent with MRSA infection control precautions. However, because of the "small number of respondents who indicated that either they or someone in their family had MRSA in the past, the chi-square test may not be a valid test" (Koltes, 2009, p. 60).

Education. Education on MRSA varies by facility and the individual HCW's needs. Physicians and nurses acknowledge education is required within their specialty relevant to MRSA colonization, infection, virulence, mortality, morbidity, risk factors and management (Easton et al., 2007). In a qualitative study conducted by Lines (2006, p.

3) six senior staff nurses felt that education was part of their responsibility and vital not only to their personal development, but to others. One participant stated, "If I am not educated how can I teach anyone else." Many hospitals are accredited by The Joint Commission and fall under the mandates of The Joint Commission Safety Goals (TJC, 2012). To be compliant with the 2012 goals the healthcare facility must provide documentation of measured elements of performance that includes education of all HCWs about multidrug-resistant organisms and prevention strategies at hire and annually thereafter as relevant to the HCW's roles within the hospital. Additionally, the facility must educate patients, and their families as needed, who are infected or colonized with a multidrug resistant organism about prevention strategies.

The HCW who receives regular education and training may possess a greater knowledge and positive attitude or perceptions concerning MRSA (Phillips, Golagani, Malik, & Payne, 2010). Burkitt and colleagues (2010) instituted education programs targeting gaps in knowledge to improve MRSA prevention practices. After education, knowledge scores increased from a mean of 3.52 at baseline to 3.64 correct. Multimodal interventions including education have been utilized by researchers to increase hand hygiene adherence with success and reduced MRSA incidence (Eldridge et al., 2006; Mathai, George, & Abraham, 2011; Vernaz et al., 2008). Other researchers suggest there is no correlation between MRSA education and self-reported adherence to MRSA prevention practices. Koltes (2009) reported respondents who received formal MRSA education were not more likely to report that they were consistent with MRSA infection control precautions and the level of education was not significantly correlated with

reported adherence. Respondents who believed they had received adequate MRSA education were not more likely to report that they were consistent with MRSA infection control precautions. Even with education programs, the HCW's knowledge gained will be dependent on the individual's learning styles and differences attributed to variations in hospital environments, hospital-based educational programs, or other training (Bush-Knapp, Brinsley-Rainisch, et al., 2007). The CDC researchers recognized when MRSA is not perceived as a problem, the HCW will not be able to overcome barriers. Therefore, educational and intervention efforts should address the HCW's perceptions of the problem of antimicrobial resistance on the individual level as a first step in motivating them to engage in quality improvement (Bush-Knapp, Budnitz, et al., 2007).

Benefits of Preventing Transmission

The HCW's attitudes concerning MRSA and perceptions to the benefits of implementing MRSA transmission prevention practices are strong predictors of adherence to practice protocols (Whitby et al., 2007). Researchers suggest the perceptions that healthcare-associated infections are severe for the patient ranks highly as a determinant of hand hygiene behavior (Sax et al., 2007). Grant and Hoffman (2011, p. 1494) agreed stating, "Because … healthcare professionals … tend to be overconfident about personal immunity, the most effective messages may be those that highlight the consequences for other people" or the patient. The altruism theory was tested with matched and randomly assigned hospital units using personal consequences and patient centered consequences posters as the intervention. The hand hygiene adherence increased significantly when HCWs were reminded of the implications for patients

(80.69% to 89.20%), but not when they were reminded of the implications for themselves. Internationally, HCWs perceive patient safety as a primary motivator for adherence to infection prevention practices, as well as a benefit for them (Da Silva et al., 2010; van Gemert-Pijnen et al., 2005). In the U.S. a higher majority of participants agreed that cleaning their hands will decrease their patient's risk (93.2%) of getting MRSA than decrease their risk (90.4%). In comparison there was no difference between the perception of benefit of wearing gloves and gowns for the patient's benefit versus the HCW's benefit (Burkitt et al., 2010).

Barriers to Implementing MRSA Prevention Guidelines

Several research studies have identified barriers to implementing infection prevention practices. Gershon and colleagues (2000) assessed the relationship between hospital safety climate of six different organizational dimensions and (1) employee compliance with safe work practices and (2) incidents of workplace exposure to blood and other body fluids; a study that is relevant to other infectious disease exposures. Of the dimensions, senior management support for safety programs, absence of workplace barriers to safe work practices, and cleanliness/orderliness of the work site were significantly related to compliance to the bloodborne pathogen standard. In addition, both senior management support for safety programs and frequent safety-related feedback/training were significantly related to workplace exposure incidents. The most significant finding in terms of enhancing compliance and reducing exposure incidents was the importance of the perception that senior management was supportive of the safety program. The most significant factor related to the elimination of barriers to

enhance adherence to hand hygiene and contact precautions may be senior management support (Eldridge et al., 2006; Haas & Larson, 2007; Lukas et al., 2010; Sax et al., 2007).

Lack of time. Lack of time is a commonly reported barrier to adherence of infection prevention practices. The majority of respondents (62%) in Germany indicated they were "able to comply in hectic situations", yet only 46% indicated they had sufficient time to comply with preventative measures (van Gemert-Pijnen et al., 2005). Burkitt and colleagues (2010) reported 4.6% of 952 HCWs felt that it took too much time to clean their hands before contact with a MRSA patient or their room. Additionally, 12.9% of 952 respondents felt that it takes too much time to gown and glove before contact with a MRSA patient with the highest scores coming from the physician group with 21.6% agreeing. De Wandel and colleagues (2010) reported a negative attitude of 148 nurses toward time-related barriers was significantly associated with noncompliance ($\beta = -.147$; $P < .001$). Time, a universal problem in healthcare, is directly associated with adherence to infection prevention practices.

Work load. In healthcare staff members may consider the barriers of time and workload in a symbiotic relationship where one factor affects the other. As the workload increases, the time factor relevant to nonadherence increases proportionally. Koltes (2009) reported that 88% of respondents identified lack of time as a factor influencing MRSA cross-infection and 60% identified their work load. Other study participants have said they were "too busy" or there were "insufficient number of professionals" hindering adherence (Da Silva et al., 2010; Eldridge et al., 2006). High workload, patient to nurse ratio, is recognized as a risk factor and significantly associated with reduced hand

hygiene adherence (Lee et al., 2011; Pittet et al., 2004). Time factors and high workloads may be expressed in terms of work intensity, and the number of opportunities for hand hygiene per hour of care. Pittet and colleague (2000) observed more than 20,000 hand hygiene opportunities of HCWs and found a link between higher demand and reduced compliance. Later Pittet (2001) reported adherence worsened when the demand for hand cleansing was high and on the average decreasing by 5% (± 2%) per 10 opportunities per hour when the intensity of patient care exceeded 10 opportunities per hour. In 887 observations of 163 physicians, high workload was associated with reduced adherence (Pittet et al., 2004). When comparing adherence in terms of internal motivational factors, "the intensity of work activity in the clinical setting may be more predictive of adherence to hand hygiene" (O'Boyle, Henly, & Larson, 2001, p. 352).

Lack of equipment. A basic requirement of implementing precautions is the availability of the equipment to complete adherence practices. Eveillard and colleagues (2001) assessed the availability of equipment in the rooms of patients on contact precautions for multiple resistant organisms and found: 74.8% of rooms had antiseptic soaps; 78.9% had gloves, 75.8% had gowns; 57.8% had 'wash your hands' signs; and 83.7% of MRSA patients were placed in a single room or cohorted. Surveillance conducted in three New York City hospitals identified a deficit in availability of supplies: 85.4% of isolation rooms had signs, 93.7-96.7% had an isolation cart, but 49.9% to 72.1% had 3 sizes of gloves, and 91.7% to 95.2% had gowns available (Clock et al., 2010). Lack of appropriate supplies is a globally reported barrier to adherence with transmission prevention measures (Da Silva et al., 2010; Oliveira, Cardoso, &

Mascarenhas, 2010). Additionally, inaccessibility to alcohol based sanitizers and hand washing sinks affects adherence to hand hygiene practices (Bischoff, Reynolds, Sessler, Edmond, & Wenzel, 2000; Oliveira et al., 2010; Sakamoto, Yamada, Suzuki, Sugiura, & Tokuda, 2010). Bischoff and colleagues (2000) reported significantly higher handwashing rates after introduction of accessible alcohol-based hand products and installation of one dispenser per bed. Additionally, they reported the amount of alcohol-based hand sanitizer used for one patient per day (lag time, 0 month; $P = .011$) was the only factor significantly associated with the MRSA incidence density rates. The problem of inaccessibility may be aggravated when dispensers are empty (Eldridge et al., 2006; Jang et al., 2010).

Communication. Good communication among staff members concerning facts relevant to implementing MRSA transmission prevention practices will promote adherence to recommended protocol (Da Silva et al., 2010). Gershon and colleagues (2000) recognized "minimal conflict and good communication among staff members" as an organizational safety dimension that effects employee compliance with Universal Precautions and reduces exposures to blood and other body fluids. Communication barriers between different disciplines have been noted, particularly related to housekeeper notification of isolation requirements (Trigg et al., 2008). Jang and colleagues (2010) remind us that communication is a component of professionalism and open, respectful communication will facilitate adherence to MRSA prevention.

Environmental cleanliness. Multiple studies have identified MRSA in patient rooms contaminating blood pressure cuffs, beds, tables, computer key boards, sink

faucets, soap dispensers, door handles, privacy curtains, and linens (Devine, Cooke, & Wright, 2001; Dietze et al., 2001; Faires et al., 2012; Griffith, Malik, Cooper, Looker, & Michaels, 2003; Ohl et al., 2012; Oie, Hosokawa, & Kamiya, 2002; Sexton, Clarke, O'Neill, Dillane, & Humphreys, 2006). HCWs, patients, and visitors have identified good ward hygiene as a measure to prevent the spread of MRSA (Gill et al., 2006). Additionally, HCWs believe MRSA is present in their work environment with 65% agreeing in the survey by Burkitt and colleagues (2010) and 81% in the survey administered by Koltes (2009). Cleanliness and orderliness of the work site is a significant predictor for compliance to Universal Precautions (*OR* = 3.3, 95% CI: 2.2 - 4.9). HCWs who report their work site is clean and orderly are 3 times more likely to report adherence to safe work practices (Gershon et al., 2000). HCWs are often frustrated with potential transmission related to inanimate objects such as patient equipment (Jang et al., 2010). One HCW stated: "It's the equipment… or blood pressure cuff or whatever, it's never wiped off." Another stated: "So, you can wash hands until you're blue in the face; the equipment is still going to carry it around" (Jang et al., 2010, p. 147).

Patient compliance. Many HCWs feel "frustrated with what they perceive as risk of transmission associated with patients and visitors" (Jang et al., 2010, p. 147). When asked 64% of 411 HCWs felt patients are contributing factors in cross infection of MRSA (Trigg et al., 2008). In the U.S., 68% of HCWs felt compliance of the patients was a risk factor for cross-infection of MRSA and 6% felt the patient was the most influential factor (Koltes, 2009). Randle, Arthur, and Vaughan (2010) included patients and visitors in their observational study of hand hygiene and reported adherence in 56%

of patients and 57% of visitors. The patient often relies on their HCW to provide the opportunity to clean their hands. Educational programs and encouraging the patient to remind their HCW to wash their hands promotes patient empowerment and increases patient adherence to hand hygiene (Burnett, 2009; McGuckin, Taylor, Martin, Porten, & Salcido, 2004).

Summary

This literature review identifies the relationship of knowledge of MRSA, perceptions of MRSA, and practices that prevent the transmission of MRSA. Knowledge is associated with increased adherence to MRSA transmission prevention practices when the perceptions of severity and susceptibility are increased. Each individual HCW brings to their work environment their perceptions, attitudes, and fears which will be suppressed or heightened by their knowledge and their work circumstances. The gaps identified in this review include:

- inconsistencies between knowledge of contact precautions and adherence to recommended practice guidelines;
- knowledge gap between HCW groups on the meaning of colonization with the support staff less knowledgeable;
- knowledge gap between HCW groups on mode of transmission of MRSA to patients;
- knowledge gap of bacterial survival at low levels, mean 59%, with inconsistencies between HCW groups;

- knowledge gap of most effective hand hygiene methods at low levels with inconsistencies between HCW groups; and
- lack of information on knowledge of community-acquired MRSA.

This study assessed the current state of the HCW's knowledge, perceptions, barriers, and practices in order to institute education programs targeting gaps in knowledge to improve MRSA prevention practices.

CHAPTER THREE METHODOLOGY

Study Design

This study used three different methodologies to gain a comprehensive understanding of the relationships between healthcare workers' knowledge, perceptions, and demographic characteristics with their MRSA transmission prevention practices. First, a survey about the HCWs' knowledge, perceptions, and practices was implemented with internet and paper methods. Second, on initiation of the survey hand hygiene observations were completed to provide comparative data of hand hygiene practices, self-reported and observed. Third, HCWs were interviewed using a semi-structured approach with four scripted questions. The data collected using observational and interview methods complement the survey data for a richer understanding of the relationship between the HCW knowledge, perceptions, and practices in adherence to the recommended guidelines on preventing transmission of MRSA. This design provides more flexibility in participation for the HCW. The survey was completed at their convenience as time permitted.

Ethical Considerations

The research protocol was approved by the George Mason University's Institutional Review Board and the facility Institutional Review Board (IRB). (See APPENDIXES A) An informed consent form was included in the Zoomerang on-line

prior to the survey window. Acceptance of the consent permitted participant access to the survey electronically. Paper survey takers were provided an IRB approved informed consent form prior to completing the survey. The facility IRB did not require a signed consent for the survey research.

Each interview participant received an IRB approved informed consent form specific to the study facility. The consent form was signed in the presence of the researcher prior to the interview. Participants voiced understanding of the risk, the benefits, and that the interview could be stopped at any point in time.

Survey Methodology

Population and sampling. The target population was the healthcare worker at an acute care community hospital. A convenience sample was obtained from the population. For the purposes of this study, healthcare workers are all personnel who have direct patient contact or enter patient care areas. Eligibility and inclusion criteria were as follows: (1) healthcare worker at the selected acute care hospital, (2) discipline group member must have direct patient contact or enter patient care areas, and (3) ability to complete survey online or alternatively by written format. No exclusion criteria were stated.

With the assistance of the Nursing Research Scientist (Chair of the Research Council) and the Director of Infection Prevention the recruitment information was electronically distributed to HCWs through the electronic information system to department management. The hospital Research Council was presented the study protocol in July, 2012, and actively engaged in recruitment of participants at the

September, 2012, committee meeting. Presentations to the nursing management group and the hospital management group were completed in September, 2012, to promote the study and distribute paper surveys and study posters. The MRSA research information was posted on the hospital system's research web page and reported in the hospital newsletter to acquaint the HCW of the opportunity for participation. Weekly visits to the hospital units to distribute and collect surveys were completed. The Chief Medical Officer and the President of the Medical Staff facilitated two lunch presentations and a medical staff meeting presentation. Additionally, the research was presented at the resident physician's meeting. Seventeen site visits were completed in the ten weeks the survey was open on-line for participation. The survey, published on Zoomerang Survey Center, was open until a minimum of 260 completed surveys, combined on-line and total surveys, were received with a minimum of 44 in each of the four respondent categories: (1) Medical Staff (i.e., physicians, physician assistants and nurse practitioners on medical staff), (2) Nurse Staff (i.e., registered nurses and other clinical staff in nursing areas), (3) Allied Health Professionals (i.e., cardio-pulmonary therapist, physical medicine and rehabilitation staff, laboratory staff, social services, case management, dieticians, and pharmacy staff), and (4) Support Staff (i.e., environmental services, food services, security, patient access, and clinical engineering on nursing units). The survey research was initiated August 29, 2012 and the last survey was accepted on November 21, 2012.

A completed survey is defined as all 31 closed questions being answered. Incomplete surveys are included in the descriptive statistics, but subject to review to determine inclusion into data analysis. Paper surveys were provided to participants with

limited computer access and to encourage participation. The paper survey packet included the introductory e-mail sent with the electronic introduction, a copy of the IRB approved informed consent, the survey, and a detached form to volunteer as an interview participant. Responses from paper survey and the on-line survey were entered into Statistical Package for the Social Sciences (SPSS) version 20.

Sample size. The survey research was conducted at a 183 bed hospital in the mid-Atlantic region of the United States (U.S.) with an estimated 1200 HCW. A response rate of 50% or less for surveys administered via the internet is possible as noted Polit and Beck (2008, p. 242). Therefore, an estimate of 600 HCWs may respond with incentives. Incentives were not permitted in the study hospital. However, through the Research team support and promotion of the research survey the required sample size of 260 completed surveys was achieved.

The sample size was determined by the statistical analysis requiring the largest sample. The logistic regression model for Research Question 6 included 13 predictor variables (one knowledge variable, six perception variables, and six demographic variables). To achieve stability in the parameter estimate, a samples size of 260 or more was determined with 20 cases per predictor (Polit, 2010).

Instrumentation. The survey questionnaire was adapted from three instruments used in other studies.

Survey #1 was created and utilized in17 VA Medical Centers (Burkitt et al., 2010) in 2009. Respondents included 1362 employees at baseline and 952 employees at follow-up: physicians (9%), nurses (38%), allied health professionals (30%), and other support

staff (24%). Additionally, the survey was implemented in a 97 bed community hospital in Virginia by this surveyor with 226 participants at baseline and 242 post-interventions.

Survey #2, originated and utilized at Nottingham University Hospital in the United Kingdom (Trigg et al., 2008), was completed by 411 HCWs including 47 physicians, 203 registered nurses, 67 unregistered nurses, 58 allied health professionals, and 33 support staff.

Survey #3 is a replication of Trigg and colleagues' (2008) survey modified by Koltes (2009) in 2009 for utilization as a dissertation study at North Dakota State University. The 225 participants included 17 physicians or mid-level providers, 118 nurses, 30 certified nurse assistants and technicians, 43 student nurses, and 17 support staff.

Permission was obtained via electronic mail from Ms. Burkitt, lead author of the original study of Burkitt and colleagues (2010), to use the tool in the current study with permission for revisions as applicable. Seventeen knowledge, attitude, and barrier question were incorporated into the survey developed for this study. Permission was obtained via electronic mail from Mr. Stephen Timmons, co-investigator of the original study of Trigg and colleagues (2008), to use the survey tool with permission to revise as applicable to this study population. Seven questions were included from this study with modifications. Two additional questions concerning the individual practices of gloving, gowning, and hand hygiene were incorporated from the Trigg and colleagues' survey. Permission was obtained via electronic mail from Ms. Leslie Koltes to use the dissertation survey tool with permission to modify as applicable to this study population.

Three additional questions were included with adaptations from Ms. Koltes' survey tool. Questions concerning media influence, meaningful education, personal experience with MRSA, and concern will transmit MRSA to family were converted from "Yes" or "No" responses to Likert with 1 being "Strongly disagree" to 5 being "Strongly agree" to provide consistency in measurement of perception variables. Details of the concept and operational definitions are described in Table 1. One additional question was added to address individual preferences concerning informational materials to provide MRSA education.

The surveys were transcribed from the original publications into survey format and prepared for validation. Although, the original survey of Burkitt and colleagues (2010) was designed by experts in MRSA infection, survey design experts, and the VA's quality improvement office, the survey required validation prior to implementation. Neither the Trigg and colleagues (2008) nor Koltes (2009) included testing for validation or internal consistency reliability. Content validity index was performed on the survey by ten Infection Preventionist and two education specialists. These specialists were instructed to rate all items as follows: (1) the item relevance to a survey about MRSA knowledge, perceptions, and practices; (2) whether you believe the item is clearly worded. Items were to be rated as 1 (not relevant) to 4 (quite relevant) for content and 1 (needs revision) to 4 (quite clear) for clarity. These professionals rated all items as quite or highly relevant and clear or quite clear with all but one question receiving a mean score of .80 or higher, the lowest score being .75. The scale level Content Validity Index

(CVI) average of the I-CVI for all items was .97 for relevance and .98 for clarity (Polit & Beck, 2006).

Content validity was then performed by six HCWs who were members of the study hospital's research council. These members were instructed to rate the relevance of each item on the survey according to the 4-point option rating scale (1=Not relevant, 2=Somewhat relevant, 3=Quite relevant, and 4=Highly relevant); and to rate the clarity of each item on the Survey according to the 4-point option rating scale (1= Not clearly written with no potential for revision, 2= Not clearly written and needs major revision, 3= Clearly written, but needs minor revision, and 4= Clearly written.) These members rated all items as quite or highly relevant and clear or quite clear with all questions receiving a mean score of .83 or higher. The scale level CVI average of the I-CVI for all items was .98 for relevance and .97 for clarity. Additionally, a pilot study of 6 participants evaluated the face validity and clarity of each question. No further revisions to the survey were required.

On completion of the data collection Cronbach's alpha analysis by Statistical Package for the Social Sciences (SPSS) version 20 was used to evaluate the internal consistency of the variables measured by the Likert scale, the calculated total knowledge score, and the practice score. A reliability coefficient of .503 was realized with a .613 Cronbach's Alpha based on standardized items. The reliability coefficient may be increased to .595 by eliminating Question 17 (Q.17) concerning the news media influence on attitudes. A reliability coefficient of 0.7 or above indicates acceptable internal consistency (Bland & Altman, 1997). The Cronbach's alpha score on the survey scale

does not indicate an acceptable internal consistency when utilized in this mixed group. Further evaluation and revision of the survey are necessary prior to replication in other groups.

Data collection. On-line survey data was saved (downloaded) in Excel from the Zoomrang survey site. Data was cleaned and responses categorized for SPSS import. Knowledge question responses were converted to correct or incorrect responses for analysis. Knowledge and each perception variable were calculated to provide a total score for analysis or as indicated conceptual and operational definitions Table 1. Paper survey responses were entered into SPSS version 20.

Data analysis. Prior to data analysis, all study variables were inspected for outliers, irregularities, and missing data. Issues arising from the inspection were first verified with original data to ensure accuracy. A complete survey required the participant to answer the three practice adherence questions used to calculate Hypotheses 3, 4, and 5.

Descriptive statistical analysis was used to describe the characteristics of the sample. Frequency distributions were calculated to describe study variables with nominal and ordinal levels of measurement. Study variables with interval and ratio level measurement were described using measures of central tendency and variability. Specifically, the mean and median score, as well as, the standard deviation and range of each distribution are reported as appropriate. Analysis of Research Questions 1, 7, 8, and 9 was completed with descriptive statistics. The study sample's knowledge, perceptions, attitudes, preferred resources, barriers, and suggestions to prevent transmission of MRSA are included in descriptive statistics.

For all analyses, alpha was set at 0.05. Parametric and nonparametric statistical analysis were conducted to evaluate the nature of the relationships between the discipline group variables related to six knowledge variables and the 18 perception and three practice variables. The non-parametric test makes no assumptions about the distribution of the data. Analysis was conducted as appropriate for the variables in the research hypotheses and research questions as indicated below.

Hypothesis 1, there are differences in the level of MRSA knowledge among the four response groups: Medical Staff, Nurse Staff, Allied Health Professionals, and Support Staff (Research Question 2), was tested with one-way analysis of variance (ANOVA). This test analyzed the mean differences of knowledge, a continuous dependent variable (DV), between and within the mutually exclusive HCW groups of Medical Staff (physicians), Nurse Staff, Allied Health Professional, and Support Staff, the independent variable (IV). The sample size of 44 each group provides a medium effect size of .25, power of .80, and alpha level of .05 with three degrees of freedom (Cohen, 1988, p. 315).

Hypothesis 2, certain demographic variables are best predictive of knowledge concerning MRSA (Research Question 3), was tested with simultaneous multiple regression. The categorical demographic variables (IV) include age, gender, education, HCW group, full-time status, and years in healthcare field. The knowledge variable was measured by six questions about MRSA with a score of 0 to 6. Sample size with the standard multiple regression formula for six predictors ($n \geq +8k$) is 98 for a moderate

effect size of $r^2 = 0.13$ (Mertler & Vannatta, 2005, p. 171). Post-hoc tests will be used if the null-hypothesis is rejected.

Hypothesis 3, there is a relationship between knowledge and practice adherence (Research Question 4), was tested using simple bivariate logistic regression. The knowledge variable was measured by six questions about MRSA with a score of 0 to 6. Respondents were split into two groups, those that report adherence with all three practice questions and those who did not report adherence with all three questions. Logistic regression was used to determine the predictive effect of knowledge on the probability of adherence to MRSA prevention practices of hand hygiene, wearing gloves, and wearing gowns when caring for patients in MRSA contact precautions. The estimated minimum sample size for the model utilizing the regression formula, $n = 20k$, with one predictor variable was 20 (Polit, 2010).

Hypothesis 4, there is a relationship between practice adherence to MRSA transmission prevention guidelines and perceptions of the Health Belief Model (Research Questions 5), was analyzed using bivariate logistic regression. The perceptions of susceptibility to MRSA infection, severity of MRSA infection, perceived barriers, perceived benefit of practice adherence, self-efficacy to take action, and cues to take action are quantitative variables measured on a Likert scale 1 to 5 as described in Table 1. The variable component responses of five perceptions in the Health Belief Model, seen in Figure 1, were totaled to create a new variable. The sixth perception variable, Model Barriers, was created by totaling the number of barriers identified by respondent with a range of 0 to 6 barriers. Logistic regression was used to determine the predictive effect of

the six Model Perceptions (susceptibility, severity, barriers, benefit, self-efficacy, and cues to action) on the probability of adherence to MRSA prevention practices of hand hygiene, wearing gloves, and wearing gowns when caring for patients in MRSA contact precautions. The estimated minimum sample size for the model utilizing the regression formula, $n = 20k$, with six predictor variables was 120 (Polit, 2010).

Hypothesis 5, there is a predictive relationship among knowledge, perceptions, and demographic characteristics (IV) to adherence (DV) to MRSA transmission prevention guidelines (Research question 6), was tested using logistic regression. Logistic regression was used to test the independent variables as the Health Belief Model components of perceived susceptibility to MRSA infection, perceived severity of MRSA infection, perceived benefit of practice adherence, perceived barriers, self-efficacy to take action, and cues to take action. Additionally, logistic regression was used to determine which individual variables affect the probability of adherence to MRSA prevention practices of hand hygiene, wearing gloves, and wearing gowns when caring for patients in MRSA contact precautions. Therefore the regression formula for estimating sample size, $n = 20k$, was used to calculate sample size. The minimum sample size for the model with 13 predictor variables (one knowledge variable, six perception variables, and six demographic variables) is 260 (Polit, 2010).

Limitations. The limitations of the study survey component include a selection and a participation bias. Self-selection favored those participants who were interested and motivated to participate in the research. Participation bias was also to those HCWs who had access to e-mail. To compensate for this limitation, paper surveys were available.

Additionally, unequal groups were anticipated due to the higher proportion of nursing staff compared to other departments.

Hand Hygiene Observation Methodology

Further exploration of adherence to guidelines to prevent transmission of MRSA included direct observation of hand hygiene adherence. Direct hand hygiene observations provide information to compare the staff members' self-reported adherence with actual adherence observed on patient units.

Sample. The target population was the healthcare worker at an acute care community hospital completing the survey component. A convenience sample was obtained from this population of healthcare workers who have direct patient contact or enter patient care areas. A minimum of 104 hand hygiene opportunity observations were completed at randomly chosen times and places to evaluate adherence to hand hygiene guidelines by healthcare workers in patient service areas.

Sampling methodology. Data collection of hand hygiene observations was completed utilizing the World Health Organization's (WHO) internationally distributed form from the Saves Lives: Clean Your Hands Guide to Implementation. (WHO, 2009b) Identification of hospital units was removed from the form as requested the hospital system to prevent recognition of the HCWs that were observed. The modified form was used to assess the HCW's adherence with three moments of hand hygiene: (1) before touching a patient, (2) after touching a patient, and (3) after touching patient surroundings, with each moment being an individual observation.

Data collection. Rounding with hospital staff provided hand hygiene observation opportunities that included the four healthcare worker groups. Adherence was recorded in terms of percentage of opportunities the HCWs adhered to hand hygiene guidelines (Erasmus et al., 2010). Data was categorized by HCW groups, missed opportunities, and adherence with hand rubs or hand washing. The study researcher, with 16 years of practice in infection prevention and control, was the observer for this section of the research. Participants in the observational study of hand hygiene were blinded to the observations and identified by respondent group. A minimum of 104 hand hygiene opportunity observations were completed at randomly chosen times and places to evaluate adherence to hand hygiene guidelines by healthcare workers in patient service areas. To prevent the "Hawthorne effect" of increased adherence to practice guidelines from the HCW's awareness of observations, the observations periods were unannounced (Maury, Moussa, Lakermi, Barbut, & Offenstadt, 2006). Multiple observations per single patient encounter were permissible (Eldridge et al., 2006).

Data entry and analysis. Hand hygiene observations were transcribed from work sheet to Excel spread sheet for tabulation. Descriptive statistics were completed as appropriate for the small sample size.

Limitations. The limitations of the hand hygiene observation component included the proportionally higher number of nursing staff and the methodology required by the facility. An unequal number of observations per HCW group were anticipated because of higher proportion of nursing staff in most patient care areas. Often only 2 or 3 Support Staff may be assigned to work per shift and the Allied Health professionals

round to their assigned patients in the care areas reducing the opportunities for observation. Observed HH opportunities are then bias to the nursing staff. The hospital system required a staff member to accompany the observer, which limited the opportunities to complete HH observations to another person's schedule.

Interview Methodology

The third component of research to explore HCWs' adherence to guidelines to prevent transmission of MRSA was interviews of participants. The interview process explored barriers to implementing isolation precautions or appropriate hand hygiene. The interviews also explored the HCWs' perceptions by asking how MRSA affects them. The participants were given the opportunity to voice their opinion of other measures that prevent transmission of MRSA in their work area. This information may assist managers in identifying barriers and solutions to implementing guidelines that prevent transmission of potential pathogens in the healthcare care setting.

Sample. Participants in the interview section were a convenience sample of HCWs who have completed the survey. A minimum of 25 interviews Polit & Beck, 2008, p. 358) was required. Recruitment was through referrals from the Infection Preventionist, department managers, Research Council members at the healthcare facility, and self-selection.

Sampling methodology. The on-line survey participants were provided an independent, non-traceable link to submit contact information and the paper-survey participants were provided a separate form to submit contact information to become interview participants. Of the 44 volunteers, 26 interviews were completed with

participants recruited from all four study groups. Interviews were conducted at the convenience of participants in the hospital cafeteria and on the working unit. The interview narrative times ranged from 3.3 to 9 minutes with an average interview recording of 5.75 minutes.

Interview analysis. Eligibility criteria for the interview survey were: (1) healthcare worker at the research study facility, (2) with direct patient contact or enter patient care areas, and (3) ability to complete survey online or alternatively by written format. No exclusion criteria are stated.

Semi-structured interviews with 26 individual participants were comprised of the two questions included in the on-line/paper survey and two additional questions:

1. Please tell me how you feel MRSA affects you?
2. Please tell me your suggestions of ways to prevent transmission of MRSA.
3. We know that isolation precautions and appropriate hand hygiene prevent transmission of bacteria, including MRSA. How are you challenged in your work task when you have to enter an isolation room?
4. Please list barriers that prevent implementing isolation precautions or appropriate hand hygiene.

The interview addressed the following research questions:

1. R.Q. 8: What are the barriers to the healthcare worker implementing practices of adherence to MRSA prevention guidelines?
2. R.Q. 9: What are the suggestions to prevent MRSA?

Interviews were tape recorded and transcribed verbatim into a word processing document. Field notes were kept to record descriptive and reflective data gathered during the interview. Accurate transcription was verified by the researcher and verified separately by a professional consultant, an Infection Preventionist formerly certified in Infection Control and Prevention with a degree of Master of Science in Nursing. The data was then transcribed into Excel and sorted by question and themes.

A directed content analysis with an open and selective continuous review of the data by the researcher and two research consultants with experience in qualitative analysis and published works identified multiple data points per individual conversation (Hsieh & Shannon, 2005). These data points were further divided and transferred into the appropriate subcategory. Independent and group review continued until the researchers were in agreement with all data categorization.

Quotations included in this manuscript were denaturalized to focus on the content of the interviews (Oliver, 2005). Exact replications of all spoken words with involuntary vocalizations such as *Hm, OK, Ah, Yeah, You know* and repeated words such as *It's* are removed for ease of the reader. Additional words that may imply ethnicity are not included to prevent the study report from compromising a participant's integrity, confidentiality, or anonymity.

Additionally, the MRSA survey responses to the open-ended Questions 32 and 33 were transcribed into Excel with the interview data. Directed content analysis by the team followed the themes and sub-categories identified in the survey analysis. Informational data from both the survey and the interviews were then combined to provide rich

information concerning optional ways to prevent MRSA transmission and barriers that prevent adherence to infection prevention guidelines.

Limitations. The limitations of the interview component include a selection and a participation bias. Self-selection favored those participants who were interested and motivated to participate in the research. Participation bias was also limited to those HCWs who were able to step away from their duties, able to meet at lunch time, or willing to interview during non-working hours. To compensate for this limitation, interview times were set over a 3 hour span of time during lunch, weekdays, and Saturdays. Additionally, rounding to patient care areas and support departments was completed to interview HCWs.

Data Management

Information about survey participants is confidential and managed according to the requirements of the Health Insurance Portability and Accountability Act of 1996 (HIPAA). Privacy and confidentiality of all enrolled participants is maintained through the use of a personal identification numbers (PIN) assigned by Zoomerang. Paper surveys added to the data collection were assigned a PIN reference in the computer file. No personal identifiers were requested on the survey instrument. A cross reference for interview participants to the PIN assigned the transcribed data was created.

Data Storage

Paper data collection sheets will be stored in a locked safe for 3 years after completion of this study. Electronic data will be stored on a password protected computer.

Summary

This study of the knowledge, perceptions, and practices to prevent MRSA transmission among acute care HCWs is a mixed method design utilizing a cross sectional survey questionnaire. Direct hand hygiene observations provide comparative data to self-reported hand hygiene adherence. Interviews to enhance the survey open ended questions relevant to transmission of MRSA prevention and barriers to hand hygiene provide rich supplemental data. The complex design provides for complementary approaches to understanding the relationships of the HCW's knowledge, perceptions, and practices regarding MRSA transmission prevention.

The survey instrument was created from previous research studies for a total of 33 questions. Two comment questions were included in the interview pre-scripted questions concerning barriers to instituting MRSA prevention practices or suggestions for implementing these practices. The hand hygiene observation data collection utilized a modified WHO hand hygiene data collection form. Analysis of the hypotheses was completed through descriptive and statistical analyses including logistic regression, ANOVA, multiple regression, Chi^2, and Fischer's Exact test. Interview and survey comment data were analyzed through directed content analysis with an open and selective continuous review of the data.

CHAPTER FOUR RESULTS

Sample

A total of 286 participants returned surveys and 276 were included in the descriptive statistics. The excluded surveys were ineligible for inclusion in the analysis: eight entries submitted with no answers, one commented could not read the practice questions, and one incomplete survey did not check the informed consent. Of the 330 paper surveys distributed 183 were completed and returned for a paper response rate of 55%. Additionally, 93 completed surveys were submitted on the Zoomerang survey site, for a total of 276. The on-line survey access was used by 36.7% of Support Staff, 20.0% of Allied Health Staff, 12.5% of the Medical Staff, and by 4.4% of the Nurse Staff of the 276 respondents.

In Table 2 the sample demographics are reported by HCW group including discipline/department, age, gender, education, years of experience, and work hours status. The majority of the 276 respondents were Nurse Staff (n = 129, 40.6%) of whom 112 (86.8%) were registered nurses. Sixty-nine respondents (25.3%) reported their age group as 36 to 45 years. The majority were female (78.0%, n = 209). Thirty-six percent indicated they had a bachelor degree (n = 100). Work experience for the HCWs ranged from 0 to 45 years (M = 13.65, SD = 10.77) with the Medical Staff reporting the highest work experience years (M = 17.5, SD = 11.74).

Table 2 Characteristics as a Percentage of Survey Research Sample (*N* = 276)

Characteristics	Nurse	Support Staff	Medical	Allied Health	Total
Discipline *n* (%)	***N* = 129**	***N* = 50**	***N* = 49**	***N* = 48**	***N* = 276**
Registered Nurse	112(86.8)				112 (40.6)
Other nursing staff[a]	17 (13.2)				17 (6.5)
Environmental		10 (20.0)			10 (3.6)
Registration/Clerical		27 (54.0)			27 (9.8)
Other Support Staff[b]		13 (26.0)			13 (4.7)
Medical Doctor			41 (83.7)		41 (14.9)
Other Medical Staff[c]			8 (16.3)		8 (2.9)
PM&R[d]				10 (20.8)	
Laboratory				10 (20.8)	10 (3.6)
Medical Imaging				15 (31.2)	15 (5.4)
Other Allied Health[e]				13 (27.1)	13 (4.7)
Age range *n* (%)	***N* = 128**	***N* = 48**	***N* = 49**	***N* = 48**	***N* = 273**
Under 18- 25 years	19 (14.8)	4 (8.3)	3 (6.1)	3 (6.2)	29 (10.6)
26-35 years	31 (24.2)	11 (22.9)	8 (16.3)	14 (29.2)	64 (23.4)
36-45 years	33 (25.8)	9 (18.8)	13 (26.5)	14 (29.2)	69 (25.3)
46-55 years	32 (25.0)	12 (25.0)	12 (24.5)	12 (25.0)	68 (24.9)
56 years or older	13 (10.2)	12 (25.0)	13 (26.5)	5 (10.4)	43 (15.8)
Gender *n* (%)	***N* = 126**	***N* = 48**	***N* = 46**	***N* = 48**	***N* = 268**
Male	11 (8.7)	11 (22.9)	24 (52.2)	13 (27.1)	59 (22.0)
Female	115 (91.3)	37 (77.1)	22 (47.8)	35 (72.9)	209 (78.0)
Education *n* (%)	***N* = 128**	***N* = 50**	***N* = 48**	***N* = 47**	***N* = 273**
Medical School			41 (85.4)		41 (15)
Doctorate	1 (0.8)	1 (2.0)		5 (10.6)	7 (2.6)
Master Degree	15 (11.7)	5 (10.0)	4 (8.3)	9 (19.1)	33 (12.1)
Bachelor Degree	73 (57.0)	10 (20.0)	3 (6.2)	14 (29.8)	100 (36.6)
Diploma/Certificate	6 (4.7)	8 (16.0)		6 (12.8)	20 (7.3)
Associates Degree	29 (22.7)	11 (22.0)		12 (25.5)	52 (19)
High School/GED/less	4 (3.1)	15 (30.0)		1 (2.1)	20 (7.3)
Experience [years]	***N* = 125**	***N* = 49**	***N* = 48**	***N* = 47**	***N* = 269**
Range	0 - 43	0 - 30	0 - 45	0 - 33	0 - 45
Mean	13.99	8.26	17.50	14.45	13.65
SD	11.07	7.65	11.74	9.79	10.77
Work Status *n* (%)	***N* = 127**	***N* = 47**	***N* = 46**	***N* = 47**	***N* = 267**
Full-time	84 (66.1)	37 (78.7)	38 (82.6)	33 (70.2)	192 (71.9)
Part-Time	27 (21.3)	6 (12.8)	8 (17.4)	11 (23.4)	52 (19.5)

PRN	16 (12.6)	4 (8.5)	3 (6.4)	23 (8.6)

Note: [a]Other nursing staff = Certified Nursing Assistant, Emergency Medical Technician, and others; [b] Other Support = Engineering/Security and Food Service; [c]Other Medical staff = Medical Assistants, Medical Students, and Nurse Practitioners; [d]PM&R (Physical Medicine and Rehabilitation = Physical Therapy, Occupational Therapy, Speech Therapy); [e]Other Allied Health = Dietician, Pharmacist, Respiratory Therapist, and Social Services

Research Question 1

What are the knowledge, perceptions, and self-reported prevention practices of the healthcare worker concerning MRSA transmission prevention in the acute care setting? Three multiple choice and three True/False questions assessed the HCW's knowledge about MRSA transmission prevention with a potential knowledge score of 0 to 6 with one point for each correct answer. Of the six knowledge questions, Question 20 was answered with the greatest accuracy (*n* = 264, 98.1% accurate): "Which of the following precautions should be taken before contact with MRSA patient or items in their room?" (Answer is Hand cleaning, Gloving, and Gowning, or All of the above.) Question 24 was answered with the least accuracy (*n* = 93, 34.6% accurate): Which hand hygiene method is most effective in killing MRSA? (Answer is Alcohol-based hand rubs.) Additionally, Question 23 was answered with low accuracy (*n* = 110, 40.9%): How long can MRSA live outside the body on surfaces? (Answer is Days.) Eighteen (6.7%) respondents accurately answered all six questions, 82 (30.5%) accurately answered five questions, and 107 (39.8%) accurately answered four questions. No statistical significance was identified among knowledge scores of HCW groups in Questions 20, 23 and 24. In comparison significant differences were identified among groups in the remaining three questions (Table 3) using Pearson Chi-Square (two-sided) tests:

- Question 21: People who have (or carry) MRSA but do not have symptoms can spread MRSA? (Answer is True.) The Medical Staff knowledge score (97.9%) and the Allied Health score (95.6%) was higher than the Nurse Staff (86.5%) and the Support Staff (74.0%).
- Question 22: How is MRSA most often spread to patients? (Answer is Healthcare worker's hands.) Knowledge score of the Medical Staff (89.6%) was higher than the Support Staff (64.0%).
- Question 25: Historically, MRSA infections occurred in hospitalized patients (HA-MRSA), but now these infections are common in the community and called community-acquired MRSA (CA-MRSA)? (Answer is True.) Knowledge score of the Medical Staff (93.8%) was higher than the Allied Health (66.7%) and the Support Staff scores (42.0%). The Nurse Staff score (82.5%) was higher than the Support Staff (42.0%).

Table 3 Knowledge of MRSA as a Percentage of HCW Group (*N* = 269)

Knowledge Question *n* (% Correct Answers)	**Nurse** ***N* = 126**	**Support Staff** ***N* = 50**	**Medical** ***N* = 48**	**Allied Health** ***N* = 45**	**Total** ***N*=269**
20. Precautions before contact? (Ans. Hand Hygiene, Gown, Gloves)	124 (98.4)	49 (98.0)	46 (95.8)	45 (100)	264 (98.1)
21. People do not have symptoms can spread MRSA. (Ans. True)	109 (86.5)	37 (74.0)	47 (97.9)	43 (95.6)	236*** (87.7)
22. How is MRSA most often spread? (Ans. Hands)	95 (75.4)	32 (64.0)	43 (89.6)	32 (71.1)	202* (75.1)

23. How long can MRSA live outside the body on surfaces? (Ans. Days)	51 (40.5)	21 (42.0)	23 (47.9)	15 (33.3)	110 (40.9)
24. Hand hygiene is most effective? (Ans. Alcohol rubs)	49 (38.9)	12 (24.0)	17 (35.4)	15 (33.3)	93 (34.6)
25. MRSA is common in community? (Ans. True)	104 (82.5)	21 (42.0)	45 (93.8)	30 (66.7)	200*** (74.3)
Mean (*SD*) score for knowledge of MRSA	4.22 (.85)	3.44 (1.01)	4.60 (1.08)	4.02 (1.18)	4.10*** (1.08)

NOTE: *Pearson Chi-Square (two-sided) tests were used; * $p < .05$; ** $p < 0.01$; *** $p < 0.001$

Perceived susceptibility to MRSA infection, severity of MRSA infection, benefit of practice adherence, self-efficacy to take action, and cues to take action were assessed in 12 statements measured by Likert scales 1 to 5 with 1 being strongly disagree and 5 being strongly agree. Table 4 reports respondents that agreed and strongly agreed with the perception statements. Over 90% (n = 250) of respondents agreed that MRSA is a national problem, but only 47.8% (n = 130) agreed that MRSA is a problem in their hospital. Over 93% agreed that cleaning their hands and wearing gowns and gloves decreases their risk (n = 256) and their patient's risk (n = 262) of getting MRSA. The least influential perceptions were the influence of the media (24.3%, n = 66) and of knowing someone with MRSA (21.6%, n = 59). Three perceptions were identified to have significant difference between groups:

- MRSA is a national problem was significantly different by HCW (Fisher's Exact test p = 0.032). The Medical Staff (95.9%) and Allied Health (95.8%) agreed with the perception more than the Support Staff (80.0%).

- When we are short staffed on my unit, MRSA is spread more than when we are fully staffed ($x^2 = 8.348$, $df = 3$, $p = 0.039$). The Medical Staff (44.9%) agreed with the perception more than the Support Staff (18.0%).
- I am comfortable with educating patients and their families about MRSA ($x^2 = 20.082$, $df = 3$, $p < 0.001$). The Medical Staff (83.3%) agreed with the perception more than the Support Staff (48.0%). The Nurse Staff (78.3%) agreed with the perception more than the Support Staff (48.0%).

The perceived barriers are described in Research Question 8.

Table 4 Perceptions of MRSA as a Percentage of HCW Group (*N* = 276)

Strongly Agree or Agree[a] Respondents of sample/*N* *N* (%)	**Nurse** ***N* =129[b]**	**Support Staff** ***N* = 50[c]**	**Medical** ***N* = 49[d]**	**Allied Health** ***N* = 48[e]**	**Total** ***N*=276[f]**
MRSA is a national problem.	117 (91.4)	40 (80.0)	47 (95.9)	46 (95.8)	250 (90.9)[†]
MRSA is a problem in this hospital.	66 (52.0)	18 (36.0)	27 (55.1)	19 (41.3)	130 (47.8)
If I clean my hands and wear gowns and gloves as recommended, I will decrease my patients' risk of getting MRSA.	118 (92.9)	47 (94.0)	46 (93.9)	45 (95.7)	256 (93.8)
If I clean my hands and wear gowns and gloves as recommended, I will decrease my risk of getting MRSA.	124 (96.1)	48 (96.0)	45 (91.8)	45 (97.8)	262 (95.6)

When staff on this unit do not gown and glove before touching a patient with MRSA, I feel comfortable reminding them.	108 (83.7)	42 (84.0)	42 (85.7)	43 (89.6)	235 (85.1)
When staff on this unit(s) do not clean their hands, I feel comfortable reminding them.	98 (76.6)	43 (86.0)	38 (77.6)	37 (78.7)	216 (78.8)
When we are short staffed on my unit, MRSA is spread more than when we are fully staffed.	44 (34.6)	9 (18.0)	22 (44.9)	16 (34.0)	91 (33.3)*****
I am concerned that I will transmit MRSA to my family and/or friends at home.	62 (48.1)	30 (60.0)	20 (41.7)	22 (46.8)	134 (48.9)
Someone I know had MRSA and the experience influenced my attitude towards MRSA.	24 (18.6)	11 (22.0)	13 (26.5)	11 (24.4)	59 (21.6)
I am comfortable with educating patients and their families about MRSA.	101 (78.3)	24 (48.0)	40 (83.3)	32 (69.6)	197 (72.2) *******
The news media influenced my attitude toward MRSA.	29 (22.7)	17 (35.4)	10 (20.4)	10 (21.3)	66 (24.3)
I have received meaningful education regarding MRSA.	93 (72.7)	33 (66.0)	35 (71.4)	38 (82.6)	199 (72.9)

NOTE: [a] Percentage answering agree or strongly agree. Statements originally measured by Likert scales 1 to 5 with 1 being strongly disagree and 5 being strongly agree ; [b]Nurse $N = 124 – 129$; [c]Support Staff $N = 48 – 50$; [d]Medical Staff $N = 48 – 49$; [e]Allied Health $N = 45 – 48$; [f]Total $N = 273 – 276$;
*Pearson Chi-Square (2-sided) test were used; * $p < .05$; ** $p < 0.01$; *** $p < 0.001$; [†]Fisher's Exact [†]$p < .05$

The self-reported prevention practices of the HCW concerning MRSA transmission prevention were measured by Question 26 with "Yes" or "No" responses:

Please indicate if you consistently practice the following:

1. Wear gloves when entering a MRSA isolation room.

2. Wear gowns when entering a MRSA isolation room.
3. Perform hand hygiene before and after touching patients?

A new variable was created to split into two groups, those that report adherence with all three practice questions and those who do not adhere with all three questions. Four respondents failed to answer all three questions. Therefore, 262 were retained in the analysis of adherence to all practices. In Table 5, HCWs reported higher consistency in wearing gloves and hand hygiene than in wearing gowns. When scored on adherence with all prevention recommendations, 84.4% (n = 221) reported consistent adherence in practice.

Table 5 Practice Adherence by HCW group (N = 265)

Please indicate if you <u>consistently</u> practice: Adherence n (%)	**Nurse** ***N* = 124**	**Support Staff** ***N* = 49**	**Medical** ***N* = 48**	**Allied Health** ***N* = 44**	**Total** ***N* = 265**
Wear gloves when entering a MRSA isolation room.	118 (95.2)	44 (89.8)	47 (97.9)	44 (100)	253 (95.5)
Wear gowns when entering a MRSA isolation room	107[a] (87.0)	42 (87.5)[a]	42 (87.5)	43 (97.7)	234[a] (89.0)
Perform hand hygiene before and after touching patients?	116 (93.5)	47 (97.9)[b]	46 (95.8)	42 (95.5)	251[b] (95.1)
Adherence with wearing gloves, gowns, and Hand Hygiene.	98 (79.7)	40 (85.1)	41 (85.4)	42 (95.5)	221[c] (84.4)

NOTE: [a] Nurse Group N = 123, Support Staff N = 48, Total N = 263; [b] Support Staff N = 48, Total N = 264; [c] Nonadherent group n = 41, Total N = 262
*Pearson Chi-Square Statistically Significant at $p < .05$, No Statistical Significance between groups

Prevention practices of the HCW's peers concerning MRSA transmission prevention were measured by Question 27 with "Yes" or "No" responses:

Please indicate if other staff members consistently practice the following:

1. Wear gloves when entering a MRSA isolation room.
2. Wear gowns when entering a MRSA isolation room.
3. Perform hand hygiene before and after touching patients?

Sixteen respondents did not answer the questions and two respondents failed to answer all three questions for a total $N = 260$ completing all survey practice questions concerning their colleagues. HCWs reported other staff consistently adhered to wearing gloves (85.4%) more than in wearing gowns (76.2%) or performing hand hygiene (76.7%). When scored on adherence with all prevention recommendations, 65.4% ($n = 170$) reported other staff consistently adhered to practice recommendations in comparison to 84.4% in practice self-reporting.

Research Question 2

Do differences exist in the level of MRSA knowledge among the four response groups: Medical Staff, Nurse Staff, Allied Health Professionals, and Support Staff?

Knowledge was assessed by six questions as reported in Table 2. Participants with missing knowledge data were excluded from the analysis. The sample size of 269 with greater than 44 participants per group achieved a medium effect size of .25, power of .80, and alpha level of .05 with three degrees of freedom (Cohen, 1988, p. 315). Hypothesis 1 (Research Question 2), there are differences in the level of MRSA knowledge among the four response groups, was tested with one-way analysis of variance (ANOVA). The mean

differences of knowledge, the continuous Dependent Variable, between and within the mutually exclusive HCW groups of Medical Staff, Nurse Staff, Allied Health Professionals, and Support Staff were analyzed.

New variables were created to transform the answers selected into a score of correct or incorrect, and to total the correct scores per respondent into a knowledge score of 0 to 6. Leven's test of equality of variance (p = .015) indicated absence of homogeneity of variances within groups. ANOVA results presented in Table 6, indicated a significant main effect for knowledge score among HCW groups, F = 11.963, p < .001, partial n^2 = .119. Post hoc testing with Tamhane identified statistically significant higher scores of the Medical Staff (M = 4.60, SD = .676) compared to the scores of the Nurse Staff (M = 4.22, SD = .987, p = .026), Allied Health Professional (M = 4.02, SD = 1.118, p = .021), and Support Staff (M = 3.44, SD = 1.181, p < .001). Post hoc testing also indicated statistically significant higher Nurse Staff scores (M = 4.22, SD = .418, p < .001) compared to the Support Staff scores (M = 4.02, SD = .418).

Table 6 ANOVA and Effect Size of Knowledge Score by HCW Group (N = 269)

Source	**Sum of Squares**	***df***	**Mean Square**	***F***	***p***	***ES***
Between Groups	36.100	3	12.033	11.963	***P*<.001**	.119
Within Groups	266.555	265	1.006			
Total	302.655	268				

Knowledge Question ***M* (*SD*)**	**Nurse** ***N* = 126**	**Support Staff** ***N* = 50**	**Medical** ***N* = 48**	**Allied Health** ***N* = 45**	**Total** ***N*=269**

Mean (*SD*) score for knowledge of MRSA	4.22 (.85)	3.44 (1.01)	4.60 (1.08)	4.02 (1.18)	4.10 (1.08)

NOTE: ANOVA test was used.

Research Question 3

What demographic variables are best predictive of knowledge concerning MRSA? Hypothesis 2 (Research Question 3), certain demographic variables are best predictive of knowledge concerning MRSA, was tested with simultaneous multiple regression. The demographic variables (IV) included five categorical (age, gender, education, HCW group, and full-time status) and one continuous (years in healthcare field) variable. Knowledge about MRSA was measured by six questions. New variables were created to transform the answers selected into a score of correct or incorrect, and to total the correct scores per respondent into a knowledge score of 0 to 6. Participants with missing knowledge data were excluded from the analysis. The sample size of 243 achieved the moderate effect size of $R^2 = 0.148$ (Mertler & Vannatta, 2005, p. 171).

Nominal level variables were recoded into individual dichotomous variables for regression analysis as follows:

- Age of 18 years to 25 (reference group), age 26 to 35, age 36 to 45, and age 46 and older;
- Gender of male = 0 and gender of female = 1 (reference group);
- Education of MD and Doctorate, Masters, Bachelors, Diploma/Certificate and Associates, and High School/GED and less than High School (reference group);

- Healthcare Worker group of Medical Staff, Nurse Staff, Allied Health Professional (reference group), and Support Staff ;
- Hours worked per week for Full-Time, Part Time, and PRN (reference group).

Standard multiple regression was conducted to determine predictors of MRSA knowledge score. Age, gender, education, HCW group, years in profession, and work hour status variables were included in the regression model with dichotomous recoded variables. No outliers were identified with a Mahalanobis distance greater than 13.816, the critical value for chi square at $p < .001$ with $df = 2$ (Mertler & Vannatta, 2005, p. 178). The normality assumption was evaluated through skewness, kurtosis, and Kolmogorov-Smirnov test. All statistics for normality were between 1.0 and -1.0 except for gender (moderate skewness -1.395) and hours worked (moderate skewness 1.502). Kolmogorov-Smirnov test indicated the distributions were non-normal significance at $p < .001$ related to the skewness of the gender and hours worked. Scatter plots displayed general distribution with clustering right and left for the gender and hours worked. Residual plots indicated close proximity of the variables to the slope line and generalized distribution above and below the regression line. For all variables the collinearity statistic tolerance test was greater than .100 indicating absence of high inter-correlation among the predictor variables.

The standard multiple regression results indicated that the overall model was a statistically significant predictor of the MRSA knowledge score, $R^2 = .170$, $R^2_{adj} = .119$, $F(14, 228) = 3.340$, $p < .001$. This model accounts for 17.0% of the variance in MRSA knowledge score. A summary of regression coefficients is presented in Table 7 and

indicates that only two variables (HCW group member SS and Full Time Work Status) significantly contributed to the model. Post hoc testing of variables with Tamhane for unequal variances assumed indicated statistically significant higher Medical Staff scores (M = 4.60) compared to Nurse Staff scores (M = 4.22, p = .026, 95% CI [.03 to .73]), Allied Health scores (M = 4.02, p = .021, 95% CI [.06 to 1.10]), and Support Staff scores (M = 3.44, p < .001, 95% CI [.64 to 1.69]). Post hoc tests also indicated significantly higher Nurse Staff scores (M = 4.22) compared to Support Staff scores (M = 3.44, p < .001, 95% CI [.27 to 1.29]). Multiple regression results indicate that an intervention targeting Support Staff to increase knowledge regarding MRSA prevention is required. Scheffè post hoc analysis for equal variances of the population indicated no significant differences in group mean of MRSA knowledge score in comparison of Full Time (M = 4.19, SD = 1.099), Part Time (M = 4.02, SD = .948), and PRN workers (M = 3.73, SD = 1.032).

Table 7 Regression Coefficients: Demographic Variables Predictive of Knowledge (N = 243)

	B	***β***	***t***	***p***	**Bivariate *r***	**Partial *r***
Age26-35	-.067	-.027	-.276	.782	-.018	-.017
Age36-45	.077	.032	.310	.757	.021	.019
Age46-older	-.093	-.043	-.331	.741	-.022	-.020
Gender	.179	.070	1.028	.305	.068	.062
Ed: Doctorate/MD	-.165	-.058	-.383	.702	-.025	-.023
Ed: Master	-.013	-.004	-.035	.972	-.002	-.002
Ed: Bachelors	-.204	-.093	-.636	.526	-.042	-.038
Ed: Diploma, Associates, Certificate	-.459	-.189	-1.454	.147	-.096	-.088
HCW: Medical Staff	.470	.165	1.470	.143	.097	.089

HCW: Nurse Staff	.164	.077	.855	.394	.057	.052
HCW: Support Staff	-.586	-.210	-2.385	**.018***	-.156	-.144
Years in Prof	.009	.094	1.055	.293	.070	.064
Full Time Work	.469	.199	2.005	**.046***	.132	.121
Part Time Work	.178	.066	.671	.503	.044	.040

NOTE: Dummy coding used for all variables except Years in the profession. MD = Medical Degree; Overall Multiple Regression Model Significance: $p<0.001$ [$R^2 = .170$, $R^2_{adj} = .119$, F (14, 228,) = 3.340]
Statistical significance is * $p< .05$; ** $p<0.01$; *** $p<0.001$

Research Question 4

What are the relationships of knowledge of MRSA and practice adherence to MRSA transmission prevention guidelines? Hypothesis 3 (Research Question 4), there is a relationship between knowledge (IV) to adherence (DV) to MRSA transmission prevention guidelines was tested using simple logistic regression. Knowledge was not a significant predictor for practice adherence using simple logistic regression. Additionally, the relationships of each knowledge questions with practice adherence were explored with chi-square tests or Fisher exact tests, but only one relationship was statistically significant.

- Q.24: Knowledge of most effective hand hygiene method: The knowledge of the most effective hand hygiene method is significantly related to practice (Fisher's Exact, $p = .041$). Medical Staff who knew that alcohol rubs are the most effective hand hygiene methods (77.4%) were significantly less likely to adhere to the practice guidelines than who did not know (100.0%).

Research Question 5

What are the relationships between practice adherence to MRSA transmission prevention guidelines and perceptions: susceptibility to MRSA, severity of MRSA, perceived benefit of transmission prevention, perceived barriers to practice adherence, self-efficacy to take action, and cues to take action? Hypothesis 4 (Research Question 5), there is a relationship between practice adherence to MRSA transmission prevention guidelines and perceptions of the Health Belief Model, was tested using logistic regression. The perceptions of susceptibility to MRSA infection, severity of MRSA infection, perceived benefit of practice adherence, perceived barriers, self-efficacy to take action, and cues to take action are quantitative variables measured on a Likert scale 1 to 5. See Table 1 for descriptions of the 12 individual variables of perception. The variable component responses of each perception in the model were totaled to create a new variable as indicated in Table 1. The Model Barriers variable was created by totaling the number of barriers identified in six dichotomous questions by each respondent with a range of 0 to 6 barriers. Two outliers were identified with screening for Mahalanobis distance resulting in a sample size of 248 HCWs with two DV groups, Adherent (n = 210) and Nonadherent (n = 38). Tolerance for all variables exceeded .100 indicating multicollinearity was not a problem.

The six Perception Model components of the Health Belief Model entered into logistic regression as a model were neither significant predictors of practice adherence nor practice non-adherence. Additional simple regression analysis of individual Perception Model components identified Self-Efficacy Model statistically significant (X^2

(1) = 5.694, p = .017) with the perception of Self-Efficacy as a moderating predictor (*B (SE)* = .192 (.080), Wald = 5.709, *OR* = 1.211; 95% CI [1.035 to 1.418], p = 0.17) having a positive effect on changing practice. Additionally, the relationships of each HCW group self-efficacy perception with practice adherence were explored with chi-square tests or Fisher exact tests, but only one HCW group relationship was statistically significant.

- Nurse Staff: The perception of comfortable reminding others to wear their gown and gloves is significantly related to practice (Fisher's Exact p = .03). Nurses who were comfortable reminding others to wear their gowns and gloves (83.5%) were significantly more likely to adhere to the practice guidelines than those who were not (60.0%). The perception of comfortable reminding others to perform hand hygiene is significantly related to practice (χ^2 = 8.03; df = 1; p = .005). Nurses who were comfortable reminding others to perform hand hygiene (86.0%) were significantly more likely to adhere to the practice guidelines than those who were not (62.1%).

Research Question 6

Among the knowledge, perceptions, and demographic characteristics, which are best predictors of adherence to MRSA transmission prevention guidelines? Research Questions 6 (Hypothesis 5), there is a predictive relationship among knowledge, perceptions, and demographic characteristics (IV) to adherence (DV) to MRSA transmission prevention guidelines, was tested using logistic regression. The model components displayed in Figure 1 of perceived susceptibility to MRSA infection, perceived severity of MRSA infection, perceived benefit of practice adherence, perceived

barriers, self-efficacy to take action, cues to take action, demographic variables (age, gender, education, HCW group, years in profession, and hours worked), and knowledge scores of MRSA were included in the standard regression equation.

A total of 276 surveys were returned with 265 responding to the practice questions. The variable component responses of each perception in the model were totaled to create a model variable as indicated in Table 1. The Model Barriers variable was created by totaling the number of barriers identified by respondent with a range of 0 to 6 barriers. Bivariate regression analysis identified six variables with significance of $p < 0.2$ that were retained to create a parsimonious regression equation: Benefit, Self-efficacy, Cues to take action, Gender, Education, and HCW group. Tolerance for all variables exceeded .100 indicating multicollinearity was not a problem.

Six variables (transformed education, HCW, gender, benefit, self-efficacy, and cues to action) were entered into the logistic regression model. Logistic regression with the enter method indicated 241 cases were included in the analysis with an overall fit of the model (-2 Log Likelihood = 179.636) representing 9.3 to 16.4% of the variability in the practice accounted for by the predictor variables in the equation (Cox & Snell R^2 = .093; Negelkerke R^2 = .164). The Hosmer-Lemeshow test indicated the model was a good fit to the data (x^2 = 9.448, df = 8, p = .306). In the multivariate relationships of the knowledge, perceptions, and demographic characteristics with practice adherence, HCW group membership and education level were significant predictors for practice adherence. Reported in Table 8 Nurse Staff (*OR* = 0.021; 95% *CI*: 0.001-0.301; p = .005) and Support Staff (*OR* = 0.024; 95% *CI*: 0.002-0.353; p = .007) were significantly less likely

to adhere to the practice guidelines than Medical Staff. Health care workers with a Doctorate or Medical Degree (*OR* = .010; 95% *CI*: .000-.244; *p* = .005) were significantly less likely to adhere to the practice guidelines than health care workers with Masters, Bachelors, Diploma/Associates, or high school or less education.

In the regression model for practice adherence using enter method, the self-efficacy (*OR* = 1.203; 95% *CI*: 0.991-1.461; *p* = .062) was not marginally significant to predict practice adherence, but the regression model using Forward logistic regression indicated that self-efficacy (*OR* = 1.187; 95% *CI*: 1.009-1.397; *p* = .039) is the only significant predictor for practice adherence or non-adherence.

Table 8 Regression Coefficients: Demographic and Perceptions Predictive of Practice (*N*=241)

					Odds	95% CI for *B*	
Predictor	***B (SE)***	**Wald**	***df***	**Sig.**	**Ratio**	**Lower**	**Upper**
High School/less[a]		9.067	4	.059			
MD/Doctorate	-4.645 (1.649)	7.932	1	**.005****	.010	.000	.244
Master	-1.271 (1.296)	.962	1	.327	.281	.022	3.558
Bachelors	-1.430 (1.189)	1.446	1	.229	.239	.023	2.462
Diploma/AD/Cert	-1.303 (1.170)	1.240	1	.265	.272	.027	2.691
Medical Staff[b]		8.584	3	**.035***			
Nurse Staff	-3.880 (1.367)	8.058	1	**.005****	.021	.001	.301
Allied Health	-1.195 (1.133)	1.112	1	.292	.303	.033	2.789
Support Staff	-3.744 (1.379)	7.371	1	**.007****	.024	.002	.353
Gender Female[c]	-.053 (.551)	.009	1	.924	.949	.322	2.791
Model Benefit	.068 (.160)	.182	1	.670	1.071	.782	1.465
Model Self-Efficacy	.185 (.099)	3.482	1	.062	1.203	.991	1.461
Model Cue to Act	.047 (.105)	.204	1	.652	1.048	.854	1.288
Constant	3.490 (2.261)	2.382	1	.123	32.80		

NOTE: Variable(s) entered on step 1; Percent correctly classified = 85.5%
Overall Logistic Regression Model Significance: $x^2 = 23.589$, $df = 11$, $p<0.015$; Negelkerke $R^2 = .164$
[a]Reference category = Education High School or less; [b]Reference category = Medical Staff; [c]Reference category =female; AD = Associates Degree, Cert = Certificate

Statistical significance is * $p < .05$; ** $p < 0.01$; *** $p < 0.001$

Research Question 7

What are the healthcare workers' preferred resources for information regarding MRSA and infection control and MRSA transmission prevention issues? Research question 7 was addressed in Survey Questions 28 (Please indicate your preferred resources for information: Infection Preventionist (Infection Control Nurse), Infection Control Manual, Manager, Colleagues, Internet or Do my own research) and 29 (Please indicate how you prefer to receive information on MRSA: Class room style, E-mail, Link to website, Flyers/Posters, or Staff meetings) with12 dichotomous variables. Seen in Table 9 the majority of respondents (64.9%, $n = 268$, range 60.8% to 71.1%) prefer the Infection Prevention Practitioner as their primary resource and their colleagues (42.5%, $n = 268$) as a secondary. Education style preference of respondents indicated 52% (range 56.2% to 50.0%) prefer e-mail communication and 50.4% prefer staff meetings, in Table 10. Four respondents wrote in other education preferences: "dailys", "ID MD", "self research", and "Webinar."

Table 9 Preferences of Resources and Education (*N* = 268)

Preferred Resources *n* (%)	Medical *N* =48	Nurse *N* = 125	Allied Health *N* = 45	Support Staff *N* = 50	Total *N* = 268
IP Practitioner[a]	31 (64.6)	76 (60.8)	32 (71.1)	35 (70.0)	174 (64.9)
IC Manual[b]	13 (27.1)	41 (32.8)	18 (40.0)	21 (42.0)	93 (34.7)
Manager	9 (18.8)	34 (27.2)	20 (44.4)	20 (40.0)	83 (31.0)
Colleagues	20 (41.7)	52 (41.6)	22 (48.9)	20 (40.0)	114 (42.5)
Internet	18 (37.5)	46 (36.8)	18 (40.0)	23 (46.0)	105 (39.2)
Do my own search	19 (39.6)	29 (23.2)	10 (22.2)	17 (34.0)	75 (28.0)

NOTE:[a]Infection Prevention Practitioner or Infection Control Nurse; [b]Infection Control Manual

Table 10 Preferences of Education Style (*N* = 269)

Preferred Education *n* (%)	Medical *N* = 48	Nurse *N* = 126	Allied Health *N* = 45	Support Staff *N* = 50	Total *N* = 269
Class Room Style	12 (25.0)	39 (31.0)	17 (37.8)	20 (40.0)	88 (32.7)
E-mail	27 (56.2)	65 (51.6)	23 (51.1)	25 (50.0)	140 (52.0)
Link to Web site	12 (25.0)	52 (41.3)	16 (35.6)	21 (42.0)	101 (37.5)
Flyers/Posters	11 (22.9)	61 (48.4)	25 (55.6)	21 (42.0)	118 (43.9)
Staff meetings	24 (49.0)	63 (50.0)	26 (57.8)	23 (46.0)	136 (50.4)

Research Question 8

What are the barriers to the healthcare worker implementing practices adherent to MRSA transmission prevention guidelines? The perceived barriers to adherence of recommended practices were addressed with 6 dichotomous variables in Q.28: What factors do you feel contribute to the transmission of MRSA in your hospital? (Answers: Lack of time to clean my hands or put on gloves and gowns, The alcohol-based hand rub and soap are not easy to reach or find, Communication, Environmental cleanliness,

Patient nonadherence with Contact Precautions, and My work load.) The majority of respondents (59.3%; *n* = 159) identified patient nonadherence as a barrier and 48.9% (*n* = 131) identified communication as shown in Table 11. (Answers were not mutually exclusive.) Seen in Table 12, communication was selected as the most influential barrier (Q.29) by 30.2% (*n* = 81) of the 268 respondents. Lack of time and patient adherence were equally identified as the second most influential barrier (*n* = 48, 17.9%)

Additional factors or barriers to practice were identified by open-ended Q.33: Please suggest other barriers that prevent implementing isolation precautions or appropriate hand hygiene. Respondents included 42 (47.7%) of the on-line and 54 (30.0%) of the paper survey groups. Six respondents replied they had no barriers to implementing isolation precautions or appropriate hand hygiene. Communication barriers included four general references and 11 concerning patient diagnosis of MRSA infection or history and related isolation inadequacies. Eleven barriers to hand hygiene included three comments about alcohol rub effects on hands, three concerning lack of alcohol rubs dispensers, and five on lack of sinks or hand cleaning stations. One nurse commented: "The alcohol based foam is very drying, so if you use it the way you should at all times the skin can be very irritating. If lotion can be right next to it, it may help staff to use it more often knowing that it won't dry them out so badly." Of these 96 respondents five indicated, "The infectious disease flags on our patients are not up to date." Five commented about "shortage of personnel" (Nurse) and pressure to complete assignments with the extra work of cleaning equipment, citing, "Pressure to get done and have time necessary to count up/down as well as appropriate time to clean equipment after use"

(Allied Health). Six respondents to write-in Q.33 (n = 96) reported nonadherence to protocols and none referenced environmental cleanliness as a barrier versus those reported in Table 11 from Q.28.

Supplementary barriers not included in the six options of Q.28 were 25 references to education. Education requirements and lack of knowledge or experience were suggested by 18 respondents. One Nurse recommended, "Education of health Care Workers and individuals that have MRSA in their medical history." Secondly, contact precaution, total 24 comments, ranked as barriers related to gowns and gloves (ten), equipment (six), "charts in isolation rooms" (two), and "no signs" or "visibility of signs" (five). Two Medical Staff reported "supplies run out" and the "carts are frequently empty." One Nurse stated, "Back of gown is open, I worry that chair I sit in … may be contaminated." Eleven respondents identified perceptions or attitudes that influence implementation of recommended practices. Medical staff responded that "No one believes that we carry infection to our patients." Therefore, inconsistencies of practice occur as one Nurse stated, "Believing contact will be minimal, so why dawn [*sic*] PPE?" Support staff also conclude misconceptions in the attitudes of "I am just doing one little thing. I don't need to use precautions just to do it**."**

Relationships between the barriers or factors contributing to the transmission of MRSA identified in Q.28 (Time, Rubs/Soaps, Communication, Environment, Patient Nonadherence, and Work Load) and practice adherence were explored with Pearson Chi-square (2-tailed) with the following statistically significant results:

- Time: The time barrier is significantly related to practice ($\chi^2 = 12.055$; $df = 1$; $p < .001$) in the Nurse Staff. Nurses who reported a time barrier (64.7%) were significantly less likely to adhere to the practice guidelines than those who reported no time barrier (90.3%).
- Work Load: The work load barrier is significantly related to practice ($\chi^2 = 10.797$; $df = 1$; $p = .002$) in the Nurse Staff. Nurses who reported a work load barrier (64.5%) were significantly less likely to adhere to the practice guidelines than those who reported no work load barrier (88.0%).

Table 11 Barriers to Prevention Practices (*N* = 268)

Barrier/Factor n (%)	**Nurse *N* = 125**	**Support Staff *N* = 50**	**Medical *N* = 48**	**Allied Health *N* = 45**	**Total *N* = 268**
Patient nonadherence	79 (63.2)	31 (62.0)	23 (47.9)	26 (57.8)	159 (59.3)
Communication	63 (50.4)	22 (44.0)	20 (41.7)	26 (57.8)	131 (48.9)
Lack of time	53 (42.4)	13 (26.0)	21 (43.8)	12 (26.7)	99 (36.9)***
Environmental cleanliness	44 (35.2)	16 (32.0)	5 (10.4)	13 (28.9)	78 (29.1)*
My work load	41 (32.8)	12 (24.0)	12 (25.0)	9 (20.0)	74 (27.6)***
Rubs/soap not easy to reach	13 (10.4)	3 (6.0)	9 (18.8)	5 (11.1)	30 (11.2)

NOTE: Factor correlated to Practice adherence or HCW Group: Chi^2 Statistical significance is * $p < .05$; ** $p<0.01$; *** $p<0.001$

Table 12 Most Influential Barriers (*N* = 253)

Most Influential Barrier/Factor *n* (%) [a]	Nurse *N* = 119	Support Staff *N* = 48	Medical *N* =46	Allied Health *N* = 40	Total *N*= 253
Communication	38 (30.4)	20 (40.0)	12 (25.0)	11 (24.4)	81 (30.2)
My work load	25 (20.0)	5 (10.0)	6 (12.5)	4 (8.9)	40 (14.9)
Lack of time	21 (16.8)	4 (8.0)	13 (27.1)	10 (22.2)	48 (17.9)
Patient nonadherence	19 (15.2)	12 (24.0)	7 (14.6)	10 (22.2)	48 (17.9)
Environmental cleanliness	15 (12.0)	6 (12.0)	2 (4.2)	4 (8.9)	27 (10.1)
Rubs/soap not easy to reach	2 (1.6)	0 (0.0)	6 (12.5)	1 (2.2)	9 (3.4)

***NOTE*: [a]** When more than 1 answer was given for which one answer was to be provided, the first response was recorded for the first half of surveys in numeric order and the last response recorded on the remainder of the surveys

Research Question 9

What are the suggestions of ways to prevent transmission of MRSA? The suggestions of ways to prevent transmission of MRSA were identified with open-ended Q.32: Please provide suggestions of ways to prevent transmission of MRSA. Of the 268 submitted surveys, 115 (42.9%) respondents suggested ways to prevent transmission of MRSA. Forty-four responded by internet survey (50.0%, *n* = 88) and 71 by paper survey (39.4%, *n* = 180). Four respondents replied they had no suggestions or N/A, including a Nurse respondent who replied: "Nothing new that we aren't already doing".

The majority of suggestions reflected the six barrier subjects of Q.33. Six commented about staffing numbers with increased workloads suggesting "less pt load for nurse w/MRSA pt's so they have more time to prep" or "change time expectation" for cleaning equipment. Twenty-four suggestions concerning hand hygiene included

education of “Effective hand washing techniques”, reminder signs, sinks or “HAND-STATIONS OUTSIDE PT ROOMS” for “convenience of compliance”, and to “enforce hand hygiene”. Twenty-four suggestions concerning contact precautions included “always remind anyone going into MRSA positive room to follow Infectious Control Guidelines” and “Make supplies easy to find, keep carts stocked.” “Greater enforcement” so that “All staff and visitors of Patients w/MRSA should use appropriate Precautions + follow the signs Posted at the Door” was the primary concern of the respondents. Communication suggestions (n = 20) included “Consistent communication on Patient Status!” and “Proper Communication from staff” related to the MRSA status of patients to include “alert PCP about need to follow-up on MRSA swabs to clear pts.”

The primary category of suggestions to prevent MRSA transmission was education with 47 diverse suggestions. One Allied Health staff suggested, “Mandatory annual inservices for all staff reminding of ways it can be transmitted + ways to avoid transmission.” Twelve respondents suggested mechanisms of educations such as staff meetings and flyers, and one requested “information clearly identifying the evidence to support isolation for MRSA + colonization patients...” (Allied Health). The broad aspects of education suggestions ranged from healthcare staff, patients, and visitors to the community medical staff and “young kids.” Education will facilitate reduction in the miscommunication experienced by the HCW: “patients aren’t upfront with them” concerning past history of MRSA because “many patients do not see the dangers” or the patient “doesn’t understand, aren’t educated about MRSA” (2 Nurse Staff). Additional

comments will be addressed in combination with the interview scripts in the Combined Analysis section.

Hand Hygiene Observation

Unannounced and blinded hand hygiene (HH) opportunities were observed on randomly selected inpatient and outpatient HCW areas with variable time allotments (15 minutes to 2 hours). Each observation was recorded by HCW group and adherence utilizing soap and water hand washing or alcohol hand rubs as seen in Table 13. Self-reported adherence rates with HH as stated in R.Q.1 were: Medical Staff (95.8%, $n = 46$), Nurse Staff (93.5%, $n = 116$), Allied Health Professionals (95.5%, $n = 42$), and Support Staff (95.9%, $n = 47$). Direct HH observations ($n = 104$) identified a consistently lower adherence in comparison of descriptive percentages to self-reported adherence with the Support Staff observation of 45.5% adherence ($n = 11$) the greatest discrepancy. (Not statistically tested.) Additionally, survey respondents reported other staff member's adherence with HH (Q. 27) was less consistent than the observed rates in all groups except the Support Staff as seen in Table 14. Random observations identified an overall lower adherence to HH recommendations than self-reported HH adherence, but higher than rates the survey participants reported for their colleagues as seen in Table 13. (Not statistically tested.) The alcohol rubs were utilized in 84.1% of the 88 ($N = 104$) Hand Hygiene actions. Due to the small sample size no statistical analysis was completed on the observations data. To provide maximum benefit from this educational opportunity, brief verbal reports of Hand Hygiene adherence were provided the department manager post observation with the assistance of the staff member as required by the study facility.

Table 13 Observations: Hand Hygiene Adherence (*N* = 104)

	Session 1	Session 2	Session 3	Total	Adherence
Nurse Staff					**88.6%**
Opp	25	2	43	70	[Act (*n*) = 62
HW	8	0	3	11	÷
HR	16	2	33	51	Opp (*n*) =70]
Support Staff					**45.5%**
Opp	5	0	6	11	[Act (*n*) =5
HW	0	0	0	0	÷
HR	4	0	1	5	Opp (*n*) =11]
Medical Staff					**94.1%**
Opp	2	0	15	17	[Act (*n*) =16
HW	0	0	1	1	÷
HR	2	0	13	15	Opp (*n*) =17]
Allied Health					**83.3%**
Opp	3	1	2	6	[Act (*n*) =5
HW	1	1	0	2	÷
HR	1	0	2	3	Opp (*n*) =6]
Total					**84.6%**
Opp	35	3	66	104	[Act (*n*) =88
HW	9	1	4	14	÷
HR	23	2	49	74	Opp (*n*) =104]

NOTE: Opp = Opportunity; Act = Hand Hygiene Actions; HW = Hand wash; HR = Hand Rub with alcohol solutions/foams. Adapted from the World Health Organization, A World Alliance for Safer Health Care, Clean Care is Safer Care, Observation Form (2009). Retrieved from http://www.who.int/gpsc/5may/tools/evaluation_feedback/en/

Table 14 Comparison of Hand Hygiene Adherence: Self-report, Colleagues, Observed

Hand Hygiene Practices n (%)	Nurse *N* = 124	Support Staff *N* = 48	Medical *N* = 48	Allied Health *N* = 44	Total N = 264
Self-Reported	116	47	46	42	251

Hand Hygiene	(93.5)	(97.9)	(95.8)	(95.5)	(95.1)
Report on Colleagues	32 (71.1)	88 (71.5)	34 (77.3)	47 (94.0)	201 (76.7)
Observation Review	70 (88.6)	11 (45.5)	17 (94.1)	6 (83.3)	88 (84.6)

Note: No statistical analysis

Interview analysis

Interview participants. Participants volunteering for the interview (N = 26) included 16 Nurse Staff, six Allied Health Professionals, three Support Staff, and one Medical Staff. The group included 24 females and two males. The median age group of those providing interviews was 36 to 45 years of age (n = 7); nine participants were younger and ten were older. Work experience mean was 16.3 years (*SD* 11.4, range 37). Twenty participants worked full time, two worked part-time, and two worked PRN hours.

Interview content analysis. The semi-structured interviews were comprised of the two questions included in the on-line/paper survey and two additional questions:

1. Please tell me how you feel MRSA affects you as a healthcare worker?
2. Please provide suggestions of ways to prevent transmission of MRSA.
3. We know that isolation precautions and appropriate hand hygiene prevent transmission of bacteria, including MRSA. How are you challenged in your work task when you have to enter an isolation room?
4. Please suggest other barriers that prevent implementing isolation precautions or appropriate hand hygiene.

The interviews addressed the following research questions (R.Q.):

1. R.Q. 8: What are the barriers to the healthcare worker implementing practices of adherence to MRSA prevention guidelines?
2. R.Q. 9: What are the suggestions to prevent MRSA?

Content analysis using a directed approach incorporated an open and selective method of coding to review the interviews multiple times during transcription and categorization (Hsieh & Shannon, 2005). A preliminary category scheme was established focusing on coding statements in the interview transcripts: hand hygiene, isolation precautions (contact precautions), perceptions or attitudes, and barriers. Additional core categories related to the central themes of the questions and categories reoccurring frequently were identified: time, knowledge or education, communication, and contamination. Barriers became a subcategory of contact precautions and were addressed as challenges. Definitions for the categories are presented in Table 15.

Selective coding through line by line analysis of each interview transcript identified subcategories related to the core categories. The "Find" word processing feature was utilized to search for key words of the core categories and related words. Table 16 presents an example of terms searched for the core category of Perception/Attitudes: "feel", "think", "perceive", "barrier", and "challenge." Data identified were reviewed in the context of the script to determine subcategories. Data points are not mutually exclusive, but applied to multiple areas as appropriate.

Table 15 Definition of Thematic Categories

Category	Definition
Perceptions/ Attitudes	Expressed feeling or opinions (See perceptions Table 1) including awareness (or lack of), perception of barriers to patient care, fear of MRSA, positive attitudes such as responsibility in care, negative perceptions such as barrier to healing touch and comfort, and empowerment (or lack of)
Contact Precautions	Related to processes of caring for patients in isolation, adherence, non-adherence, barriers, cleaning, challenges, and suggestions for change
Time	Related to time involved in planning assignments, work schedules, staffing requirements, the processes of maintaining isolation, screening, cleaning, and caring for patients
Knowledge/ Education	Related to knowledge, lack of knowledge, potential educational opportunities on general MRSA and transmission, transporting patients, cleaning, methods of education, and patient MRSA status
Communication	Communication in general, between groups, precautions signs, MRSA status, and MRSA screening
Hand Hygiene	Perception/attitude to HCW adherence for prevention, responsibility, barriers related to sinks, dispensers, and alcohol rubs
Contamination	Related to cross contamination of patients and self, contamination of the environment, and contamination of equipment.

Perceptions and attitudes. Interview Question1 determined the thematic category of Perceptions/Attitudes by requesting the participant to define the emotional impact of MRSA on their lives as an individual. The environment of the "affect" of MRSA is determined by the participant whether personal or impersonal, whether

healthcare, home, or community related. Perceptions were themed into *positive* and *negative* perceptions. As related to healthcare transmission of MRSA a positive perception is responsibility:

> First of all I feel responsible for the person that I am dealing with. That's where it really impacts me. If I touch somebody and I have not washed my hands properly then I am going to be the carrier and trigger for that MRSA to go forward. (Nurse)

Two Nurse Staff stated that MRSA does not affect them, "it is just part of [their] job" and an Allied Health Professional stated, "It's always there, and it's something you have to keep in mind." The Medical Staff comment highlights the positive commitment this HCW brings to the patient:

> So I think it affects my patients so much more than me. I feel like as a healthcare worker, we are more logical about it. [Later] People know what the right thing to do is. How do we help people do the right thing? (Medical)

Negative perceptions may impact the care of patients or facilitate transmission of MRSA. Two nurses proposed negative nurse-patient relationships:

> I think that at some point when a healthcare professional knows that her patient is infectious there is a barrier that happens. A barrier to touch, just to provide comfort or a healing touch or comfort touch. And I think that aspect of our healing ability kind of goes away when you have the barrier of the PPE and just the idea that the patient is infectious then. You want to protect yourself and of course when you go home, you want to protect your family. (Nurse)

Negative perceptions concerning personal safety may place a barrier between the nurse and the patient:

> But it doesn't feel always comfort to take care of MRSA patients every time. And if you have three isolations in your shift, you feel kind of, feel dirty after you finish your work. That's how I feel and then also, especially I have a little one at home. So sometimes I [don't]… feel very comfortable going home and touching anything. So I usually go straight to shower. (Nurse)

Consequently negative perceptions or attitudes may promote transmission of MRSA as iterated by a Support Staff:

> I think the biggest things are that people either think, "Well I'm only doing this one little task, it doesn't matter. Oh, I'm just going to pop in the room and I just need to get this one form signed. Do I really need to put on, use all the isolation or all the preventive things I should? (Support Staff)

Contact Precautions. Contact precautions were pre-determined as a category relevant to the purpose of the study. Comments were classified into sub-categories related to *work practice* or *challenges* in work practice. Fifteen comments reflected *adherence* to recommended practices of gloves, gowns, and hand hygiene, and 13 reflected *non-adherence*. As one Allied Health Staff stated:

> I feel like we have a good system in place. But, my suggestion would be just better adherence to the system. Maybe a more strict, straight forward way of having people look at the signage and the carts and gowning up and gloves and

everything. I don't feel like it is being adhered to as well. We have a good system. It just needs to be followed. (Allied Health)

Nonadherence was related to time challenges: "To come back to the room, regown, reglove, and go through the whole thing. It is very time-consuming. So, I've noticed people who take shortcuts" (Allied Health). Four participants identified physicians as the HCW not adhering to protocols for contact precautions.

Multiple challenges related to a particular work area, executing donning and doffing of gowns and gloves, equipment cleaning, and patient care were identified in responses to Interview Question 3. Support Staff stated, "A big challenge for us was just what do we need to do? We're in registration." Pre-surgical staff said, "I'm challenged in terms of the extra work that needs to be done to find out if they [patients] still need to be kept on contact precautions when they come in for the surgery." The Surgical Staff stated, "Bacteria, not only MRSA, are just ubiquitous and everywhere. There is always a risk of cross-contamination between patients and any bacteria not, only MRSA, can certainly complicate any surgical procedure and only makes it worse." Donning and doffing gowns and gloves are a challenge "when there's a safety issue and you can't just run right in" as reported by three Nurse Staff. Allied Health Staff stated: "For one thing wearing the gowns can be little over heating, if I am doing a lot of physical lifting of patients." Other HCWs identified concerns related to contaminated charts, stethoscopes, wheels, other equipment removed from isolation rooms and the time element involved in cleaning. Providing the same level of care to the isolation patient challenges the HCW who knows "it just takes more time to care for the patient" (Nurse), but, realizes "I don't

go into the patient's as frequently as I would normally go into a room because of having to gown up" (Nurse). Although 31 challenges were identified under Contact Precautions, additional challenges were appropriate to categories such as Hand Hygiene.

Time. Time emerged as a category evident in multiple aspects of discussion by the interviewees. The HCWs addressed time related *to planning and work flow*, *Contact Precautions, staffing issues,* and *time in caring* for their patients. Time was a critical issue in work planning: "As the charge nurse making our patient … assignments, we certainly wouldn't give a neutropenic patient or an immunocompromised patient to a nurse assignment with an active MRSA." Delivery of care planning is crucial for the HCW entering isolations rooms: "Well I don't think it's so much of a challenge as remembering and positioning yourself in a way that while you're with a patient you don't have to leave for other supplies." The procedural area HCW is challenged with unique planning for isolation patients: "I think we do as good of job as we can. We do make really strong conscious effort; always put the patient at the end of the day or the end of the cases. The room is thoroughly cleaned before the next patient comes in."

Time delays related to Contact Precautions were reported by six HCWs who screen patients for MRSA history prior to admission: "The challenge that it has for me is that when I'm interviewing a patient and find out that they've had a history of MRSA, it's a lot of extra work to research it out." Five HCWs identified care related delays and three equipment related delays: "It adds an extra step when you're on a busy unit. You may be bringing stuff in with you like Accu-checks. And it's just always those extra little steps that delay your efficiencies. I guess that's the challenge." (Nurse). "Then time tends

to be a barrier when you're in a hurry and have a huge patient load. You find yourself running in real quick to grab something before putting the gown on. Oh. I'm just going to grab this out of the room" (Nurse). This Allied Health staff reiterates the process involved in entering and exiting isolation: "Getting gowned, gloved, washing hands before and washing hands after, [and] cleaning my equipment. So it definitely takes a lot of time." A continuance of time requirements is evident post discharge as well: "It's a lot of time when you're putting someone into contact isolation. It restricts the rooms that we can put patients in the emergency department. It closes off rooms after the patient has been moved out of the room" (Nurse).

Time related to caring for isolation patients and staffing issues were noted seven times per topic. The HCWs acknowledged increased time to provide care and lack of support staff to provide supplies and help with tasks. "Well it definitely slows down the process. [also]If you have a patient with MRSA, sometimes you will see that patient last versus seeing them first" (Nurse). "An isolation patient really requires two people to care for them together. You have one considered contaminated and another clean" (Nurse). Then there are delays getting assistance: "I find that the patient needs a new brief or they need new linens and it's getting someone else, calling out of the room to get someone to bring in what we need …" (Allied Health).

Knowledge/education. The fourth category, Knowledge and Educational Opportunities, was identified 24 times for the *HCW* and 18 times for the *patient, visitor, and community*. Nineteen educational opportunities were general MRSA education: "of course education and awareness is just really the best tools that anybody could have"

(Allied Health). One HCW stated concerning a family member wondering the corridors while wearing his gown and gloves, "He was very thankful that I had told him, but was very oblivious to what was going on and the reasoning behind why he was wearing that stuff." The Medical staff noted: "Everybody has good intentions. We have to remind people more constantly." Generally, the interviewees reiterated "make sure that all the employees understand what MRSA is" (Nurse) and "there has to be a lot more education." Also, "lots of people don't get that education on a regular basis" (Allied Health). "I think it is all about education and I think we have to get buy-in from everybody. Everybody in the hospital, all those 42 people [*that enter the patient's room*] for 24 hours" (Medical).

Communication. Communication, the fifth category, was recognized 33 times: 13 *general* comments, 12 related to *Contact Precautions*, and eight related to the patient's *MRSA status.* Thirteen interviewees identified communication or lack of as a barrier that prevents implementing recommended practices. "Make sure they are aware, the family is aware. The lack of communications can cause lots of problems" (Nurse). Eleven remarks emphasized the absence of appropriate Contact Precautions signs, for example: "Just too many times [you] go to a new patient. Then leave the room, come back in an hour, and all of a sudden the isolation signs are up" (Allied Health). Communication on MRSA status of the patient was addressed as a barrier, a challenge, and a means of preventing transmission of MRSA. Non-communication as a barrier was reported by this HCW: "Sometimes it's difficult to find out if the patient truly still has the infection. They may say they were cleared by a doctor, not of this facility, but then they

have no documentation of it" (Support). Communication was seen as a challenge by the Medical staff: "Soon as they hit the hospital again, if they come in the admission thing flags up as positive. MRSA positive, and they get put into isolation. So we changed our flow such that the patient gets informed. The patient has a letter they can take to their primary care." Several saw communication of patient status of MRSA as a potential for preventing transmission: "Inform the PCP of the patient and say, 'Hey your patient is going home and we've advised them this, but if you guys could follow-up as well to make sure that this patient becomes negative…" (Support). One Allied Health staff reiterated the relationship of communication and prevention by stating: "Like I said communication is the biggest. It needs to be communicated right off the bat. It needs to be addressed right off the bat and it [*isolation status*] needs to be properly in place right off the bat" (Allied Health).

Hand hygiene. Hand hygiene, the sixth category, was pre-determined as a category relevant to the purpose of the study. Comments were classified into sub-categories related to *perception/attitudes* (n = 21) and reflecting *challenges* (*n* = 7) of nonadherence in work practice. As one Nurse stated:

> I feel that [if] I touch somebody and I have not washed my hands properly, then I am going to be the carrier and trigger for that MRSA to go forward. And to think what happens to people! Especially I work in joint replacement and if they have some kind of joint infection, it's epic. (Nurse)

The challenges to hand hygiene were fewer and generally related to placement of sinks:

> Well, I don't think it is a barrier, but I think if you put a sink in front of someone, versus hiding it in every other place. [Later] It would probably be easier if the those sinks and places to wash hands and things like that were right in your face so that you would bump into it to get where you are going. (Nurse)

Contamination. Contamination, the seventh category, was recognized 22 times related to: 13 *environment*, five *patients or staff*, and four *equipment.* The HCWs voiced concern for transmission of bacteria in the environment:

> It's certainly easy even when wearing gloves to touch a contaminated patient and then touch a countertop. Have any of the cleaning staff or any of the nursing staff, anyone actually come in contact with that unknowingly and transmit bacteria from one place to another. (Nurse)

Contamination and cleaning of equipment was coded into multiple categories. Related to equipment one Nurse identified concerns in patient care: "I think we need to do a better job with wiping down the surfaces of things we use all the time, like our pens, scissors, things like that we might touch while we are caring for the patient." Cross contamination between patients or staff to patients was identified by five interviewees. "So I know it affects my daily life here and I don't want to bring anything home. And I am aware we have to make sure we don't pass anything on to patients either, from patient to patient" (Nurse).

No barriers/challenges. Eleven of the interviewees stated they had no *barriers* and seven reported no *challenges*. A positive response from staff included: "I don't know what barrier, I mean they try to have sinks all over and the right equipment for us to use"

(Nurse). Often the staff identified no challenges as Contact Precautions and Hand Hygiene were a standard of practice: "I don't see a challenge. The biggest challenge is getting the cart and that's not hard" (Nurse).

Table 16 Interview Content Inductively Developed Thematic Categories with Characteristic Response

Thematic Category	Subcategory	Key terms	Characteristic interview response
Perceptions/ Attitudes ***N*** = 62	Positive Perception/ Attitude	Feel, think, perceive, barrier, challenge	N: "Otherwise it is just changing an individual's mind and habit. …I just think … making MRSA visual and making a person believe they actually can be empowered to stop the transmission."
	Negative Perception/ Attitude	Feel, think, perceive, barrier, challenge	SS: "Attitudes can be barriers, yes. It's just, you know, kind of thinking, I'm only doing something quick. I don't need, like it's not going to matter that much."
Contact Precautions ***N*** = 61	Practice (Adherence/ Non-adherence)	Prevent transmission, challenge, contact precautions	N: "Making sure you do…. Wearing the gowns and gloves when we are in isolation for MRSA." AH: "I have seen healthcare workers walk into a room un-gowned and hug an isolation patient"
	Challenges	Barriers, challenge	N: "They need more; like their acuity is very high compared to like a non-isolation patient. I just feel like if I have like of less isolation patients … I can follow all the standards that they require."

Time/Work/ Planning ***N*** **=** 56	Planning/ Work Flow	Time, challenge, work, planning	AH: “For me personally it means more time .... Getting gowned gloved, washing hands before and washing hands after, cleaning my equipment.”
	Care for patients	Time, affect, challenge	N: “Well it definitely slows down the process. Just the basic patient care ….”
	Contact Precaution	Affect, challenge, contact precautions	N: “It’s the time, it’s the time. And you know you are doing this in and out very quickly. It’s a lot of work to do it properly. A lot of thought behind it.”
	Staffing	Barrier, challenge, staff	N: “And without adequate staffing, you know, the risk is, it’s certainly increased.”
Knowledge, Education ***N*** = 41	HCW, MD office	Prevent, knowledge, barriers, education	N: “We’ve educated; we’ve done everything. I just think it's just continually, just the monitoring continually, educate people, and keep hounding them.”
	Patient/ Visitor/ Community	Prevent, challenges, barriers, education	MD: “I think it is all about education and I think we have to get buy-in from everybody. Everybody in the hospital. All those 42 people for 24 hours.”
Communication ***N*** = 33	General/ People	Communicate, challenge, tell, educate, show	AH: “Communication is the biggest. I mean, communication is the key essential.”
	Contact Precautions	Barrier, challenge, contact precautions	N: “Just the communication thing …the sign wasn’t up or we can’t find a cart. … and then people going in and not taking the precautions that they should ….”

	MRSA Status	Challenge, barrier, prevention,	MD: "So we changed our flow such that the patient gets informed, the patient has a letter they can take to their primary care."
Hand Hygiene ***N*** = 28	Perception	Feel, think, perceive, barrier, hand hygiene	N: "I have not washed my hands properly then I am going to be the carrier and trigger for that MRSA to go forward."
	Barrier	Barrier, hand hygiene, sink	N: "I think if you put a sink in front of someone, …, versus hiding it .... It would probably be easier if those sinks and places to wash hands … were … in your face so that you would bump into it …."
Contamination ***N*** = 22	Patient/Staff	Contamination, challenge	N: "We have to make sure we don't pass anything on to patients either, from patient to patient."
	Environment	Clean, prevent, transmission	AH: "We have to get the room that we take them into terminally cleaned, so we're not putting other patients at risk…."
	Equipment	Affect, prevent transmission	N: "Do a better job with wiping down the surfaces of things we use all the time, like our pens, scissors, things … we might touch while we are caring for the patient."

Note: MD = Medical Staff, N = Nurse Staff, AH = Allied Health Professional, SS – Support Staff

The responses to the four interview questions were analyzed for emerging themes through directed content analysis (Hsieh & Shannon, 2005). The analytic fit process

through continuous review of the data by the researcher and two research consultants identified multiple data points per individual conversation. These data points were further divided and transferred into the appropriate subcategory. The perceptions/attitude core category included 62 data points comprised of 45 positive and 17 negative perceptions or attitudes identified in the 26 interviews. Additionally, 11 participants identified "no barriers" and seven participants identified "no challenges" in caring for patients in isolation for MRSA. The number of data points for each core category and subcategory are displayed in Table 17.

Table 17 Interview Content Analysis (*N* = 26)

General Category	Subcategory 1	Subcategory 2	Subcategory 3	Subcategory 4
Perceptions/ Attitudes ***N*** = 62	Positive ***N*** = 45	Negative ***N*** = 17		
Contact Precautions ***N*** = 61	Challenges ***N*** = 31	Practice ***N*** = 30		
Time ***N*** = 56	Planning/ Work Flow ***N*** = 22	Contact Precaution ***N*** = 20	Staffing ***N*** = 7	Care for patients ***N*** = 7
Knowledge, Education ***N*** = 41	HCW, MD office ***N*** = 23	Patient/Visitor /Community ***N*** = 18		
Communication ***N*** = 33	General ***N*** = 13	Contact Precautions ***N*** = 12	MRSA Status ***N*** = 8	
Hand Hygiene	Perception/	Barrier		

	Attitude		
N = 28	***N*** = 21	***N*** = 7	
Contamination	Environment	Patient/Staff	Equipment
N = 22	***N*** = 13	***N*** = 5	***N*** = 4
No Barriers or Challenges	No Barriers	No Challenges	
N = 18	***N*** = 11	***N*** = 7	

Comparative Analysis

Comments and Interviews

Sample. The sample for the qualitative component of research on the knowledge, perceptions, and practices of MRSA transmission prevention among acute care setting HCWs included 115 respondents to survey Q.32, 96 respondents to survey Q.33, and 26 interview participants (previously discussed). The survey respondents (*N* = 268) included 88 on-line and 180 paper survey respondents with the following characterizations.

Survey respondents. On-line survey participants (*N* = 88) responding with comments included 44 (50%) to Q.32 and 25 (47.7%) to question Q.33 as seen in Table 18. Paper survey participants (*N* = 180) responding with comments included 71(39.4%) to Q.32 and 54 (30.0%) to question Q.33. The 129 survey respondents providing comments to one or both questions included: 69 Nurse Staff, 21 Support Staff, 25 Allied Health Professionals, and 14 Medical Staff. One hundred respondents submitting comments were female and 25 were male (four missing). The median age group of those providing comments was 36 to 45 years of age (*n* = 30); 47 respondents were younger

and 50 were older. Work experience mean was 14.8 years (*SD* 11.2, range 43). Work status/hours included 93 worked full time, 20 part-time and 13 PRN hours (three missing).

Table 18 Survey Comments Population: HCW Group as a Percentage of Internet and Paper Samples (*N* = 268)

HCW Group *n* (% within HCW	Q. 32 Prevention		Total	Q. 33 Barriers		Total
	Internet *N* = 88	Paper *N* = 180	*N* = 268	Internet *N* = 88	Paper *N* = 180	*N* = 268
Nurse Staff	29 (52.7)	33 (47.1)	62 (49.6)	78(49.1)	24 (34.3)	52 (40.8)
Support Staff	8 (44.4)	11 (34.4)	19 (42.0)	8 (44.4)	7 (21.9)	15 (30.0)
Allied Health	4 (44.4)	17 (47.2)	21 (46.7)	4 (44.4)	15 (41.7)	19 (42.2)
Medical Staff	3 (50.0)	10 (23.8)	13 (27.1)	3 (50.0)	8 (19.0)	11 (22.9)
Total (% column)	44 (50.0)	71 (39.4)	115 (42.9)	42 (47.7)	54 (30.0)	96 (35.8)

Comment content analysis. Review of the two questions included in the MRSA Survey Research was conducted on 268 returned surveys. The survey included two comment questions from the interview script, which were:

1. Please provide suggestions of ways to prevent transmission of MRSA. (Q.32)
2. Please suggest other barriers that prevent implementing isolation precautions or appropriate hand hygiene. (Q.33)

Data analysis was completed following the core and sub-category themes identified in the interview analysis. Knowledge/Educational Opportunities was the primary core category

with 85 data points comprised of 55 references to HCW education and 30 related to patient, visitor, or community educational opportunities. Additionally, seven participants indicated they identified "no barriers" in caring for patients in isolation for MRSA. The number of data points for each core category and subcategory are displayed in Table 19.

Table 19 Question 32 and 33 Content Analysis (*N* = 129)

General Category	Subcategory 1	Subcategory 2	Subcategory 3
Knowledge, Education ***N*** = 85	HCW, MD office ***N*** = 55	Patient/Visitor/ Community ***N*** = 30	
Contact Precautions ***N*** = 42	Practice ***N*** = 23	Challenges ***N*** = 19	
Communication ***N*** = 42	MRSA Status ***N*** = 18	General ***N*** = 13	Contact Precautions N= 11
Hand Hygiene ***N*** = 34	Perception/ Attitude ***N*** = 26	Barrier ***N*** = 8	
Perceptions/ Attitudes ***N*** = 22	Negative Perception/ Attitude ***N*** = 20	Positive Perception/ Attitude ***N*** = 2	
Time ***N*** = 14	Staffing ***N*** =11	Contact Precaution ***N*** = 3	
Contamination ***N*** = 14	Equipment ***N*** = 8	Patient/Staff ***N*** = 5	Environment ***N*** = 1
No Barriers ***N*** = 8			

The 321 interview and 261 survey Q.32 and Q.33 data points were combined in Excel to facilitate further content analysis of sub-categories. Three researchers reviewed the analysis independently. Discrepancies were discussed and adjusted to achieve 100% agreement. Multiple data points were possible per individual phrase resulting in multiple coding. A total of 582 data points were coded from the 26 interviews and 129 survey participants.

Knowledge and the HCW

Hypothesis 1 examined differences in the level of knowledge among the four HCW groups, identifying significantly different scores between the Support Staff and the Medical and Nurse groups. Supporting this finding, the only demographic variable identified to be predictive of knowledge was the HCW group (Hypothesis 2). A review of HCW group scores per individual knowledge question as seen in Table 3 indicated the Allied Health Professionals, Nurse Staff, and Support Staff scored higher in naming the transmission prevention precautions of hand hygiene, gloving, and gowning than Medical staff. (Not statistically significant.) Additionally, the Support Staff group scored higher at knowing the survival time of MRSA on surfaces than the Nurse Staff and Allied Health Professionals. Generally knowledge is considered directly related to formal education. Yet, knowledge is also directly related to educational opportunity and content of instruction evidenced by the higher percentage of Support Staff receiving less than high school to Associates Degree education. Content analysis of comments submitted on 129

surveys identified knowledge and educational opportunities (N = 85) for the HCW and the patient, family, or visitor as the leading comment. Additionally, the 26 interview participants, cited knowledge or education 41times. Interview participants summarize the facilities education philosophy in the statements:

> I think the two things we need to work on is the hand washing for everybody. My daughter is actually becoming a volunteer here and they told her that the average patient during a 24 hour stay has 42 people come into the room. Like really. Which I think is fascinating. I know we work on doctors. Doctors and nurses are the people that actually really touch the patient. But, I think it would be interesting to make everybody else being, [pause] tap into that the other 42, the volunteers and this and that everybody else sort of needs to be aware of it. (Medical Staff)

"I just think the education portion in making MRSA visual and making a person believe they actually can be empowered to stop the transmission is going to be our best bet" (Nurse Staff).

Of the 129 knowledge or education related comments, 64 pertained to general educational opportunities from the perspective of MRSA as a barrier or education as a means of prevention. Thirteen participants identified educational opportunities on transmission of MRSA and four regarding transporting of patients. Eight were specific to hand hygiene and five comments specific to cleaning. One survey comment submitted by a nurse, "Knowledge, the more you know about spread of disease the more likely you are

to protect yourself & others" emphasizes the importance of education to promote evidence based practices of transmission prevention for drug resistant bacteria.

Knowledge and Practice

Hypothesis 3, there is a relationship between knowledge and practice adherence to MRSA transmission prevention guidelines, was not supported by statistical analysis. Exploring the individual knowledge questions with practice by HCW group using chi-square tests or Fisher exact tests identified only one significant relationship between knowledge and practice when testing 24 potentially significant dyads (HCW group and Knowledge Question). The analysis identified a significant relationship between the Medical Staff knowledge of most effective hand hygiene method (Q.24) and practice.

Knowledge Question 24 (What hand hygiene method is most effective? Answer: alcohol rubs) was significantly correlated to practice in the Medical Staff. Knowledge that alcohol rubs are the most effective hand hygiene method may have little relevance to practice. Only 93 (34.6%) of the participants correctly answered this question. However, 251 (95.1%) indicated they performed hand hygiene before and after touching patients with an observed adherence rate of 84.6%. Additionally, knowledge of most effective Hand Hygiene (Q.24) in the Medical Staff group was directly related to practice adherence. Knowledge of Hand Hygiene effectiveness was the lowest score across all groups. As reflected by a Medical Staff and a Nurse Staff interviewee the emphasis is on hand washing, not alcohol rubs.

> Wash your hands. I am a big believer in hand washing. I actually like hand washing a lot more than the gel, because I don't like the idea of leaving dead

> germs on my hands. I like the idea of washing them down the sink. I think here in the hospital the best of intention we are really good about having the spray and the foam and all that stuff, but it is really hard to wash your hands. (Medical)

"I think if we follow the policy, that we can prevent, MRSA. If we do good handwashing and if everybody does good handwashing" (Nurse). Regardless of individual preferences, the staff demonstrated an observed 84% utilization of alcohol products in practicing hand hygiene. As one Nurse said:

> Okay because I can just foam in and foam out and I don't have to wash my hands every time. But the C diff I have to wash my hands, the foam is not going to do anything. So it would be my challenge, finding a sink to wash my hands.

Perceptions and Practice

Severity. The HCWs in the research study recognized the severity of MRSA with 90.9% agreeing there is a national problem and concurring with previous studies reporting 90.4% to 95% agreement (Brinsley et al., 2005a; Burkitt et al., 2010; Koltes, 2009). Yet, fewer respondents perceived MRSA a problem in their facility (47.8%). Fisher's exact test indicated a statistically significant relationship between the HCW groups and the perception of MRSA as a national problem ($p = .032$), but a non-significant negative association with the perception of MRSA as a hospital problem. Among the HCW groups, the Medical Staff perception of MRSA as a national problem was statistically significant in correlation to practice adherence ($r = .353$, $p = .014$).

Interview research participants accordingly perceived MRSA as a national problem "causing a lot of problems" (Nurse) with a hospital presence: "I notice there's a

lot of going MRSA, worsening. Like it's so many antibiotics overdone, over using and things like this. So [the] MRSA population is growing up so quickly, I noticed that" (Nurse). Nurse Staff voiced concern of transmission in the hospital noting:

> Lot of the problem is the patients tend to be walking the halls. They have MRSA. They go down stairs. They eat. Then they go back into their room or patient family member's. That just, that would definitely spread MRSA. (Nurse)

Other HCWs also recognized the risk of MRSA transmission in the community:

> I think of other arenas other than the hospital I'm in. Like MRSA, I work out at the gym a lot. And I know those are nasty and probably full of bacteria too. When I go in and out of the gym, I'm making sure I'm washing my face, just showering right after. (Nurse)

Susceptibility. The perception of susceptibility to MRSA was measured by two questions addressing transmission when short staffed (Q.11) and concern of transmission to family or friends (Q.13). Although only 33.3% of the respondents agreed that short staffing consequently resulted in MRSA transmission, correlation between the Medical Staff (44.9%) being more agreeable than Support Staff (18.0%) was statistically significant. Similar to a previously reported study in the U.S. (Koltes, 2009), almost half (42%) of the respondents indicated concern about transmitting MRSA. But in contrast to the low level of concern by our Support Groups, the Support Staff from the previous study reported a higher level of concern (60.0%). Although short staffing was moderately related with self-reported adherence to prevention protocols ($x^2 = 3.848$, $df = 1$, $p = .05$),

concern for transmission was not. Twelve of the interview participants voiced concern of transmission in multiple environments:

> And, it's just, bacteria, not only MRSA, are just ubiquitous and just have it everywhere. There is always a risk of cross-contamination between patients and without adequate staffing the risk is, it's certainly increased especially with just the number of patients in the operating room… (Nurse)

Transmission to family members was a primary concern to ten staff members: "You want to protect yourself and of course when you go home you want to protect your family" (Nurse). "The biggest way the, the danger of you possibly getting it or spreading it to your family or your friends or anybody outside the hospital. I mean not to mention your patients" (Allied Health). "I don't have to worry so much about myself, but I feel because I have small children at home, grandchildren. I would be devastated that I can bring that home to them. I'm a little bit more cautious" (Nurse). "It's always there, and it's something you have to keep in mind. Because I have a daughter at home and it's not something you want to pick up and take home with you. So, it's ever minding, always a presence" (Allied Health).

Benefit: The perception of benefit of MRSA transmission prevention was measured in two questions concerning the patient benefit (Q.15) and the staff member benefit (Q.10) of reducing risk when adhering to hand hygiene practice and wearing gloves and gowns. Previous researchers reported that HCW's attitudes and perceptions of the benefits of implementing MRSA transmission prevention practices are strong predictors of practice adherence (Whitby et al., 2007). Although the respondents agreed

with these perceptions, patient benefit (93.8%) and staff benefit (95.6%) there was no significant relationship between the perceptions and adherence to practice as a total group of HCWs. However, HCWs are aware of potential for transmission and the benefit of reducing transmission of MRSA through hand hygiene and wearing gloves and gowns. For example: "If you're not adequately cleaning your hands the risk of transmission to everything it's so astronomically high" (Nurse). "I think just as a nurse being focused on that to really keep in mind the consequence of you not using such a simple way to prevent infection appropriately" (Nurse). "So anyway, this kind of isolation I know that I have to be careful. As long as I dress in isolation just like they recommended for us and it should be taught that way. It should be safe for me. (Nurse)

Cues to action. The fifth construct of the Health Belief Model (Figure 1) is the cues or factors that prompt action. The perception or cues were measured by three questions related to media influence (Q.17), influence by the experience of others (Q.14), and having received meaningful education (Q.19). Less than 25% of the respondents agreed that either the media or the experience of others influenced their attitudes toward MRSA coinciding with the previous U.S. study by Kolte (2009). Alternatively, 72.5% of the survey research respondents agreed they had received meaningful education, the third cue to action. No significant relationship was identified between the cues to action and adherence to practice. However, a strong significant correlation ($r = .336$, $p < .001$) exists between meaningful education and comfort in educating patients and family. In three HCW groups, the two perceptions were strongly correlated: Medical Staff ($r = .697$, $p < .001$), Nurse Staff ($r = .311$, $p < .001$), and Support Staff ($r = .315$, $p < .035$). As one

Allied Health Professional stated: "And of course education and awareness is [sic] just really the best tools that anybody could have….with MRSA and any other condition."

Self-efficacy. The perception of self-efficacy was measured by three questions: comfort in reminding others to gown and glove (Q.9), comfort in reminding others to perform hand hygiene (Q.12), and comfort with educating patients and families about MRSA (Q.16). Simple logistic regression analysis of the three questions simultaneously as the Model Self-efficacy variable was statistically reliable (p = .018) in predicting practice adherence as suggested by previous behavioral theory modeling (De Wandel et al., 2010). The odds ratio for self-efficacy (1.21) indicated positive change in predicting practice adherence. Two measurements of self-efficacy were significantly correlated with practice adherence, comfort in reminding others to gown and glove (Q.9; Fisher's Exact, p = .03) and perform hand hygiene (Q.12; x^2 = 8.026, p = .005) in the Nurse Staff.

The term empowered or empowerment was specifically emphasized in charging administration to increase the confidence of all HCWs to action, as one Nurse stated, "making a person believe they actually can be empowered to stop the transmission…." Another Medical Staff confirmed the emphasis:

> I think we have to let our cleaning people become really empowered to help us too. They are very much a part of the team and they need to be empowered and feel like, 'Hey, like I'm on it. This is my job and I am going to help protect people.' I think a lot of our success rides on that. (Medical)

Just as self-efficacy in comfort with educating patients and families about MRSA (Q.16) was significantly correlated to receiving meaningful education, also empowerment and

self-efficacy to adhere to recommended practices are related to receiving meaningful education. Previously, Burkitt and colleagues (2010) reported increased comfort in reminding others post interventional education.

Barriers. The perception of barriers that prevent implementation of prevention practices or factors that contribute to the transmission of MRSA was identified through a dichotomous selection question and an open question. Previous researchers have reported that the absence of workplace barriers to safe work practices increases compliance (Gershon et al., 2000). Although patient nonadherence was selected most often as the contributing factor (59.3%), communication was selected as the most influential. "Non-stop communication to all population" will influence MRSA prevention practices (Nurse Staff). Yet, communication was not a contributing factor influencing practice by statistical analysis. Previous researchers have reported that time-related barriers and work intensity are significantly associated with noncompliance (De Wandel et al., 2010). Also, previous studies have recognized high workload, work intensity, and/ or patient to nurse ratio as a risk factor for nonadherence and significantly associated with reduced hand hygiene adherence (Lee et al., 2011; Pittet et al., 2004). In our study, Nurse Staff were significantly more like to report lower adherence to prevention guidelines when they reported time or work load as a barrier.

Summary

This study of the knowledge, perceptions, and practices to prevent MRSA transmission among acute care HCWs was a mixed method design utilizing a survey research questionnaire distributed through e-mail with directive to an internet service.

Paper survey became the primary method because of convenience for the respondents. Knowledge was not predictive of practice adherence, but the Medical Staff knowledge scores were significantly higher than the other HCW groups. Additionally, HCW group membership and education level were significant predictors for practice adherence. The Nurse Staff and Support Staff were significantly less likely to adhere to the practice guidelines than Medical Staff. Health care workers with a Doctorate or Medical Degree were significantly less likely to adhere to the practice guidelines than health care workers with Masters, Bachelors, Diploma/Associates, or high school or less education.

Of the perceptions, over 90% of respondents agreed that MRSA is a national problem and that they would reduce their risk and their patient's risk of acquiring MRSA if they adhere to the recommended practices. Perceived self-efficacy in reminding others to perform HH, gowning, and gloving was predictive of practice adherence in the Nurse Staff. The majority of respondents identified patient nonadherence as a barrier contributing to transmission of MRSA, and communication was reported as the most influential factor or barrier.

Direct HH observations provided comparative data to the high self-reported HH adherence. Direct observations identified a lower adherence to HH than self-reported adherence with the Support Staff observation of compliance the greatest discrepancy. The HCWs reported a lower HH adherence rate in their colleagues than in their self-report adherence.

CHAPTER FIVE DISCUSSION OF THE FINDINGS

This study showed the HCWs participating in this research study displayed an extreme variability in knowledge of MRSA and professed consistent adherence to recommended guidelines to prevent transmission of MRSA. There have been some studies (Brady et al., 2009; Easton et al., 2009; Seaton & Montazeri, 2006; Silva et al., 2010) addressing the HCW knowledge related to infection prevention practices, but few studies (Burkitt et al., 2010; Koltes, 2009) have examined knowledge of generalized practices and epidemiological factors of MRSA applicable to multiple disciplines of HCWs in the U.S. The prevalence of MRSA in hospitals and communities continues to be a problem relevant to both the HCW and the patient (Elixhauser et al., 2011; Jarvis et al., 2012; Kassis et al., 2011). In this study, the HCWs had an excellent knowledge of the practices required to prevent the transmission of MRSA, but less than half understood the epidemiology behind the essential point of consistency of practice that MRSA lives for days in the environment. The HCWs in this study reported high adherence rates to all practices, gloving, gowning, and hand hygiene before and after patient contact and surroundings, but they did not understand that alcohol hand rubs that they used consistently were more effective than soap and water.

The Conceptual Framework

The Health Belief Model (HBM) was the theoretically derived conceptual framework for this research that examined the relationship of the demographic variables, knowledge, perceptions, and the HCW's self-reported adherence to MRSA prevention guidelines. The HBM considers the likelihood of action when the elements of perceived susceptibility and severity to a health threat are balanced against the benefits and barriers or risks of nonadherence to health care recommendations. The components of cues to actions and self-efficacy were included in this model. This study identified that the Model Self-Efficacy, HCW group membership, and education were predictive of practice adherence.

Knowledge. This study identified extreme variability in knowledge of HCWs with excellent knowledge of the actions required to prevent the transmission of MRSA. Yet, they displayed limited knowledge of the effectiveness of the alcohol hand rubs or the viability of the bacterium, MRSA. When compared to the mean number of knowledge questions correctly (3.52) answered pre-intervention in the Burkitt and colleagues' study (2010), the mean score (3.37) in this research group for the same five questions is lower. Although the total mean score was lower than the previous study, this study group scored higher on knowing the practices to prevent transmission and effectiveness of the alcohol rubs.

Knowledge does not always translate into adherence with MRSA transmission prevention practices. Researchers in the Netherlands reported 87% of the 63 HCWs had an overall knowledge of preventative measures. However, in observed scenarios only 45% were able to determine tasks to prevent MRSA transmission (van Gemert-Pijnen et

al., 2005). Yet, education may translate into actions that protect HCWs from acquiring MRSA. Our findings support previous research identifying that education is significantly related to practice adherence. Recently, Rohde and colleagues reported an ongoing prospective, longitudinal cohort design study to evaluate MRSA and staphylococcus carriage in 87 nursing students at Texas State University (2012). In the study, MRSA carriage did not increase and *S. aureus* prevalence varied from 20.7% initially to 26.4% on the second "Wave testing", which is within the CDC national estimate. The researchers credited the students' knowledge and understanding gained from sensitization to risks of MRSA for the stabilization of rates and lack of increasing prevalence of MRSA. The initial orientation may have influenced the student cohort to adherence with CP and HH practices. The respondents in our study demonstrated high levels of practice knowledge. However, overall only 84.4% indicated consistency in performing HH, gloving, and gowning, similar to Koltes' research (2009) reporting excellent knowledge and 80% consistency of practice. In parallel, our group felt their colleagues consistently practiced precautions below their own reported adherence rate, but at higher adherence rates (overall 65.4% adherence) than reported by Koltes' respondents at 52%. Higher levels of consistent practice adherence lead this researcher to speculate that the HCWs in the United States are becoming more knowledgeable and translating research evidence into their daily practice.

Perceptions. Perceptions are paramount in promoting MRSA transmission preventative practices. Perceptions are the "tacit knowledge characterized as subjective, intuitive, and implied without being expressly stated" (Nichols & Badger, 2008, p. 11).

Few studies have looked at HCWs as a high-risk group in danger of contracting MRSA or whether perceived risk or susceptibility of MRSA had any impact on infection control practices (Koltes, 2009). Perceptions in this study included severity, susceptibility, benefits, self-efficacy, barriers and cues to action. Sax and colleagues (2007) reported the perception of HAI severity for patients was highly ranked as a determinant of behavior by 32.1% of 1042 HCWs. HCWs in this study perceived that MRSA is a national problem (90.9%), but not a problem in their hospital (47.8%). The CDC Campaign to Prevent Resistance Team identified similar perceptions when asking physicians their perceptions of antimicrobial resistance, citing: "92% agreed that antimicrobial resistance is a problem in hospitalized children nationally, 76% agreed that it is a problem in their institutions, and 60% agreed that it is a problem in their practice" (Brinsley et al., 2004, p. 178). Correspondingly, the VA study respondents reported 90.4% agreement with MRSA as a national problem and 65.0% as a problem in their hospital (Burkitt et al., 2010). Another CDC team lead by Bush-Knapp (2007) proposed that when HCWs do not perceive that antimicrobial resistance is a problem in their institution, then HCWs may be less likely to overcome barriers or follow transmission prevention guidelines. Therefore, educating HCWs on the perception of MRSA resistance as a factor and a risk in their own facility may be the first step in motivating adherence to recommended practices. As seen in this research, Koltes (2009) reported that the respondents who believed that MRSA was a very serious or serious issue were significantly more likely to report that they were consistent with infection control precautions.

However, in this study, the only perception questions identified to be statistically predictive of adherence to recommended guidelines were two concerning the HCW's comfort in reminding others to wear gloves and gowns and perform hand hygiene before and after touching patients. Perceived self-efficacy was the most often identified predictive and statistically significant variable correlated to practice adherence of the model components. Outcomes for self-efficacy have been measured not only in one's ability to overcome barriers, but also "increased confidence that participant can encourage" others to perform the anticipated outcome (Champion & Skinner, 2008, p. 55). All HCWs, as the composite group, reporting "increased confidence to encourage" others to gown and glove, or to perform HH were more likely to adhere to recommended practices. In one study where respondents self-reported 100% adherence to practice, 85% of them also reported comfort reminding staff and visitors who were neglecting the protective equipment and HH (van Gemert-Pijnen et al., 2005).

Practices. In this study, HCWs agreed that adhering to recommended practices of HH, gowning, and gloving reduces the HCW's and the patient's risk of acquiring MRSA. Multiple studies have supported the reduction in transmission when prevention practices are consistent (Cheng et al., 2010; Cromer et al., 2008; E. J. Halcomb et al., 2008). The dramatic difference identified between self-reported intended behavior of hand hygiene (95.1%) and observed hand hygiene (84.6%) adherence supports previous observation studies identifying less than optimal practice adherence (Shimokura et al., 2006). As suggested by van Germert-Pijnen and colleagues, "hospital staff tend to overestimate their knowledge of the preventative measures and their own skills in

applying them in everyday practice" (van Gemert-Pijnen et al., 2005, p. 382). Respondents may overestimate compliance because when implementing the precautions they are faced with barriers and practical problems that prevent them from complying with the precautions. Another reason is that when completing surveys, respondents tend to give "socially desirable answers" (van Gemert-Pijnen et al., 2005).

Many researchers have reported that observed HH adherence is less than optimal for prevention of pathogen transmission with HH adherence 48%– 69% post patient contact (Clock et al., 2010; Huskins et al., 2011). Education programs, reduction of barriers, and promoting convenience of adherence for the HCW increases adherence in HH and other MRSA transmission prevention practices (Cheng et al., 2010; Clock et al., 2010; Sax et al., 2007). The majority of this study's respondents indicated they had received meaningful education regarding MRSA (72.9%) and also comfort in educating patients and families concerning MRSA (72.2%). Not surprising though, many of the Nurse Staff, representing 47% of the respondents and the group who shoulder the responsibility for patient education, felt unequipped to educate patients. In this respondent group, 27% felt they had not received meaningful education and 22% did not feel comfortable educating patients and families. Understandably, the most frequent suggestion from survey and interview respondents for promoting adherence to transmission prevention practices was knowledge or education. Study interview participants acknowledged the lack of barriers to implementing MRSA transmission prevention practices, stating many times there were "no barriers" with an occasional request for more sinks.

Therefore, the HCW is positioned at the apex of the antimicrobial resistance phenomenon, primarily as the vector, but unfortunately as a possible victim. Previous research studies have supported that HCWs hold the key to stop the transmission of MRSA and other resistant organisms with consistent adherence to the recommended transmission prevention practices. As stated by study interview participants, health organizations and administrators must empower each individual to believe they are part of the team to fight antimicrobial resistance.

Strengths

This study comprehensively included all health care professionals and support staff in comparative analysis. Previous studies primarily focused on one group of HCWs, predominantly nurses and physicians. All HCWs that had direct contact with patients or entered patient care areas were included. The study knowledge questions were limited to generalized information relevant to all HCWs and not specific to treatments or hospital policy. Therefore, these questions are relevant to other healthcare institutions for replication. The multiple aspects of practice adherence with self-reporting, reporting of other staff members, and direct observation draw the practice spectrum into a more realistic light. As identified previously, HCWs often do not recognize their own deficiencies. But, they do observe other staff member deficiencies, and when asked will report them. The actual observations of the hand hygiene practices provided the balance between the two reports.

The focus of this study included not only the knowledge, perceptions, and barriers that influence the recommended practices of gowning, gloving, and hand hygiene, but

also explored multiple factors influencing practice through open survey questions and interviews. The complex design provided for complementary approaches to understanding the relationships of the HCW's knowledge, perceptions, and practices regarding MRSA transmission prevention. The interview dialogue and comments provided a comprehensive review of the participants' priorities of focus in the continuing MRSA challenge. The suggestions provided by these HCWs will be more relevant to their hospital administrators in developing future plans for education or elimination of barriers than the limited choices provided in the survey. Additionally, multiple distribution methods through paper distribution and the internet survey increased accessibility to the survey for the study participants.

Limitations

Limitations of this study include the small sample size of survey participants and the small hand hygiene observation sample. A larger survey sample would provide more robust statistical analysis. The small sample of hand hygiene observations limited statistical comparison with the self-reported hand hygiene adherence. Moreover, the hand hygiene observations may be an over estimation of compliance for some HCW groups, limiting the validity of this method. Even though the observer attempted to be inconspicuous, staff members may have questioned the reason a non-staff member was present in the halls observing the activities. This bias could lead to an over estimation of observed hand hygiene adherence.

This study was conducted at a community hospital and may not be generalizable to other healthcare settings, such as large university hospitals or long-term care.

Therefore, the findings are limited to other community hospitals of similar size in the mid-Atlantic region. Another limitation, self-selection, was biased to the Nurse group due to the larger proportion of nursing staff versus other HCW disciplines. Although the study attempted to understand the knowledge, perceptions, and practices of HCW groups, the groups were not mutually exclusive to standardized types of professionals. For example, the Support Staff group was comprised of a mixture of professionals: registration staff, environmental services staff, security staff, morgue transporters, and clinical engineers. Therefore, not one particular support department can be targeted for comparison with other groups and all HCWs must be included in education to effect a significant change.

MRSA rates at the study facility were not available to provide more evidence supporting reduced MRSA transmission related to the high self-reported practice adherence rates. Historical data with comparison of MRSA transmission rates and MRSA transmission prevention practice adherence would provide evidence substantiating the effectiveness of interventions. These interventions may include hospital improvements, such as installation of the alcohol hand rub dispensers, or any future activity to increase practice adherence.

Implications for Nursing and HCWs

All persons affected by the continued global emergence of antimicrobial resistance must maintain vigilance to prevent the transmission of disease just as our mentor, Florence Nightingale, did. Ms. Nightingale was a nurse leader and epidemiologist concerned with identifying health truths and implementing the truths into

practice. Her *Notes on nursing: What it is, and what it is not* (Nightingale, 1860) portrays her observational skills to identify sources of illness and implement the evidence to prevent disease. Just as Ms. Nightingale, each HCW must be observant of potential transmission of disease and implement measures to protect the patient, other HCWs, the community, and himself.

Education was the predominant suggestion across the groups of HCWs as a means to prevent transmission of MRSA. The HCWs' excellent knowledge score on the infection prevention practices with their reporting of 75% to 98% compliance indicates they are aware of the appropriate action and are able to determine their practice inconsistencies. Regardless of the knowledge scores, inconsistencies of hand hygiene practice were observed. The support staff displayed a willingness and enthusiasm to perform work practices responsibly, yet their scores for hand hygiene observation were far below their self-reported adherence. This group would benefit from further investigation into the appropriate practices concerning glove use and hand hygiene requirements and provided appropriate education. Additionally, the predictive association of the full-time work status to practice adherence, indicated the part-time HCW would benefit from additional education to increase their knowledge.

Multiple educational opportunities were identified through comments and interview suggestions. Beyond the suggestions for posters and flyers, multiple respondents indicated their desire to learn more about MRSA and requested education through their Infection Preventionist (Infection Control Nurse). Knowledge of basic epidemiological factors, such as the survival of MRSA for days and months on surfaces,

will help the HCW validate the time spent performing the gloving, gowning, and hand hygiene consistently. Additionally, meaningful education was strongly correlated with comfort reminding others to perform hand hygiene (self-efficacy) and comfort in educating patients and family (cue to action). Respondents to the VA survey reported a statistically significant increase in comfort in reminding other staff about proper HH and CP after education (Burkitt et al., 2010). Other research supports the use of interdisciplinary education through multimedia resources to allow for participative, interactive, and engaging learning experiences that increase the HCWs understanding of the complexities of patient care encountered in the MRSA epidemic (Engum & Jeffries, 2012; Levett-Jones, Gilligan, Lapkin, & Hoffman, 2012; Mikkelsen, Reime, & Harris, 2008). Multi-faceted educational programs incorporating epidemiologic factors, previous research, and a glance into the evolving era of multiple drug resistant microorganisms will support the HCW's critical thinking and promote self-efficacy and implementation of evidence-based practices that reduce MRSA transmission (Carboneau et al., 2010; Lee et al., 2009).

Previous researchers reported the importance of senior management support as a significant factor in compliance and elimination of barriers to hand hygiene and infection prevention practices (Eldridge et al., 2006; Haas & Larson, 2007; Lukas et al., 2010; Sax et al., 2007). Healthcare administrators must continually assess the working conditions in their facilities to eliminate barriers that inhibit implementation of infection prevention practices. Patient to nurse ratio, or staff workload, has been associated with urinary tract infections and surgical site infections (Cimiotti et al., 2012). Staffing workloads and

procedural time allotments must be continually evaluated for increased acuity levels due to transmission prevention practices related to multiple drug-resistant microorganisms and other transmissible infectious diseases. Cimiotti and colleagues reported, "an additional patient assigned to each nurse was associated with…a 1.351 additional infections for each patient added." As one research participant indicated, just one isolation patient per shift was "OK", but not three isolation patients per shift.

Future Research

In this study, 42.4% of the Nurse Staff selected lack of time as a barrier to implementing infection prevention practices and 32.8% selected "my work load." The Nurse Staff also reported 20.3% nonadherence in one or more practices, the highest nonadherence rate of the HCW groups. As work duties change related to electronic medical records and advanced technologies, future research of time or work load factors is suggested for identification of explicit causality of practice nonadherence.

Additionally, identification of perception variables for "cues to action" will facilitate understanding the HBM and promote implementation of MRSA transmission prevention practices. The three cues to action in this study were not statistically correlated to work practice: news media, knowing someone with MRSA, and receiving meaningful education. Yet, receiving meaningful education was strongly statistically significant in correlation to comfort in educating patients. The influence of news media may be sporadic as local incidences of mortality related to MRSA are unpublicized. Also low incidence rates of MRSA in the study facility may reduce the influence of MRSA as a personal risk. The third cue to action was the influence of knowing someone with

MRSA. The generalized statement was used to eliminate a respondent's fear of identification. Surprisingly, 21.6% agreed that knowing someone with MRSA had influenced their attitude towards MRSA. The current report by the respondents in this study was quite different from Koltes', where eight percent (8%) of the respondents indicated that either they or someone in their family had MRSA in the past. Therefore, identifying exactly what prompts the HCW to take action to prevent the transmission of MRSA would be beneficial to the healthcare environment and the community.

Replication of the study in larger hospitals systems and multiple healthcare settings, including emergency services, would provide a broader understanding of HCWs' knowledge, perceptions, and practices of MRSA prevention globally. Because HCWs and the patient navigate between healthcare settings, a study of multiple service areas may identify the weak link that promotes transfer of multiple resistant bacteria between healthcare and the community. Additionally, including more recently identified problem bacteria requiring similar transmission prevention practices, such as carbapenem resistant Gram negative bacteria (CRE) and vancomycin resistant *Enterococcus* (VRE) species, would compare knowledge and perceptions and identify additional educational opportunities. Although MRSA is the primary bacteria causing healthcare acquired bloodstream infections, further research may indicate the HCW's focus has been transferred from MRSA to less common, less virulent emerging resistant micro-organisms.

Conclusions

The HCWs at the study facility have knowledge and are compliant regarding MRSA precautions. They also recognize deficient transmission prevention practices in peers. Practice adherence and reasons for nonadherence to MRSA prevention practices must be continually evaluated in HCWs by self-assessment and direct observation with immediate feed-back. Educational interventions addressing the epidemiology of resistant bacteria such as MRSA may alter HCWs' perceptions and increase their critical thinking skills resulting in increased compliance with transmission prevention practices. Educational interventions are recommended for our study facility with follow-up studies. Just as in the VA system, other groups need to establish a knowledge base to determine if their HCWs understand the epidemiology of transmission, as well as, the practices to prevent transmission of the various multiple drug resistant microorganisms becoming more prominent in healthcare.

APPENDIX A: GMU HSRB NOTIFICATION DATED AUGUST 1, 2012

GEORGE MASON UNIVERSITY

Office of Research Integrity and Assurance

Research Hall
4400 University Drive, MS 6D5, Fairfax, Virginia 22030
Phone: 703-993-4121; Fax: 703-993-9590

TO: Kyeung Mi Oh, College of Health and Human Services

FROM: Aurali Dade
Assistant Vice President, Research Compliance

PROTOCOL NO.: 8228 Research Category: Doctoral Dissertation

PROPOSAL NO.: N/A

TITLE: Knowledge, Perceptions, and Practices of MRSA Transmission Prevention among Acute Care Setting Healthcare Workers

DATE: August 1, 2012

Cc: Dorothy Seibert

On 8/1/2012, the George Mason University Institutional Review Board (GMU IRB) reviewed and approved the above-cited protocol following expedited review procedures.

Please note the following:

1. **Any modification to your research (including the protocol, consent, advertisements, instruments, funding, etc.) must be submitted to the Office of Research Integrity & Assurance (ORIA) for review and approval prior to implementation.**
2. Any adverse events or unanticipated problems involving risks to subjects including problems involving confidentiality of the data identifying the participants must be reported to the ORIA and reviewed by the IRB.

The anniversary date of this study is 7/31/2013. **You may not collect data beyond that date without GMU IRB approval.** A continuing review form must be completed and submitted to the ORIA 30 days prior to the anniversary date or upon completion of the project. In addition, prior to that date, the ORIA will send you a reminder regarding continuing review procedures.

If you have any questions, please do not hesitate to contact me at 703-993-5381.

APPENDIX B: SURVEY

MRSA Knowledge, Perceptions and Practices Survey

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1. **Confirm you have direct contact with patients or enter patient areas?**
   ☐Yes **If you do not enter patient areas or have direct contact, do not continue.**
2. **Age**: ☐<18 ☐18- 25 ☐26-35 ☐36-45 ☐46-55 ☐56 or older
3. **Gender**: ☐Male ☐Female
4. **Education (Highest level completed)**: ☐MD ☐Doctorate ☐Masters
   ☐Bachelors ☐Diploma/Certificate ☐Associates
   ☐High School or GED ☐ Less than High School ☐Other:____
5. **Discipline/Department:** ☐Medical Doctor ☐Physician Assistant
   ☐Nurse Practitioner ☐Registered Nurse ☐Certified NA/Tech
   ☐Licensed Practical Nurse ☐Other nursing staff ☐Social Services
   ☐Cardio-Pulmonary ☐Laboratory ☐Medical Imaging
   ☐Pharmacist/Pharmacy ☐Physical Therapy ☐Speech Therapy
   ☐Occupational Therapy ☐Food Services ☐Engineering and Security
   ☐Environmental Services ☐Patient Registration ☐Other (Specify)_____
6. **Total Years in current Health Care Profession (include other hospitals)**: _____
7. **Hours worked per week at this hospital status?** ☐Full-Time ☐Part-time ☐PRN

Indicate if you (1) strongly disagree, (2) disagree, (3) are unsure, (4) agree, or (5) strongly agree with the following statements about MRSA or Hand Hygiene

Statement	Strongly disagree	Disagree	Unsure	Agree	Strongly agree
8. MRSA is a national problem.	1	2	3	4	5
9. When staff on this unit(s) do not gown and glove before touching a patient with MRSA, I feel comfortable reminding them.	1	2	3	4	5
10. If I clean my hands and wear gowns and gloves as recommended, I will decrease **my risk** of getting MRSA.	1	2	3	4	5
11. When we are short staffed on my unit, MRSA is spread more than when we are fully staffed.	1	2	3	4	5
12. When staff on this unit(s) do not clean their hands, I feel comfortable reminding them.	1	2	3	4	5
13. I am concerned that I will transmit MRSA to my family and/or friends at home.	1	2	3	4	5
14. Someone I know had MRSA and the experience influenced my attitude towards MRSA.	1	2	3	4	5
15. If I clean my hands and wear gowns and gloves as recommended, I will decrease **my patients' risk** of getting MRSA.	1	2	3	4	5
16. I am comfortable with educating patients and their families about MRSA. (**1** = very **un**comfortable, **5** = very comfortable)	1	2	3	4	5

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	Strongly disagree	Disagree	Unsure	Agree	Strongly Agree
17. The news media influenced my attitude toward MRSA.	1	2	3	4	5
18. MRSA is a problem in this hospital.	1	2	3	4	5
19. I have received meaningful education regarding MRSA.	1	2	3	4	5

20. Which of the following precautions should be taken before contact with MRSA patients/items in their room**?** **(Check all that apply)**	☐ Hand Cleaning ☐ Gloving ☐ Gowning ☐ All of the above ☐ Do not know
21. People who have (or carry) MRSA but do not have symptoms can spread MRSA.	☐ False ☐ True ☐ Do not know
22. How is MRSA most often spread to patients? **(Check only one answer)**	☐ Overuse of antibiotics ☐ Through the air ☐ Bedside equipment ☐ Health care worker hands ☐ Do not know
23. How long can MRSA live outside the body on surfaces? **(Check only one answer)**	☐ Seconds ☐ Minutes ☐ Hours ☐ Days ☐ Do not know
24. Which hand hygiene method is most effective in killing MRSA? **(Check only one answer)**	☐ Alcohol-based hand rub ☐ Plain soap and water ☐ Antimicrobial soap & water ☐ None of the above
25. Historically, MRSA infections occurred in hospitalized patients (HA-MRSA), but now these infections are common in the community and called community-acquired MRSA (CA-MRSA)?	☐ False ☐ True ☐ Do not know **(Check only one answer)**

26. Please indicate if **you <u>consistently</u>** practice the following:

Wear **gloves** when entering a MRSA isolation room.	☐Yes	☐No
Wear **gowns** when entering a MRSA isolation room.	☐Yes	☐No
Perform **hand hygiene** before and after touching patients?	☐Yes	☐No

27. Please indicate if **other staff members <u>consistently</u>** practice the following:

Wear **gloves** when entering a MRSA isolation room.	☐Yes	☐No
Wear **gowns** when entering a MRSA isolation room.	☐Yes	☐No
Perform **hand hygiene** before and after touching patients?	☐Yes	☐No

MRSA Study Survey Research

28.What factors do you feel contribute to the transmission of MRSA in your hospital?

Please check ALL that apply.

_____Lack of time needed to clean my hands or put on gloves and gowns

_____The alcohol-based hand rub and soap are not easy to reach or find

_____Communication

_____Environmental cleanliness

_____Patient nonadherence with Contact Precautions

_____My work load

29.From question 28, which factor do you consider being the **MOST** influential in the risk of MRSA transmission in your hospital?

Please check ONE box only.

_____Lack of time needed to clean my hands or put on gloves and gowns

_____The alcohol-based hand rub and soap are not easy to reach or find

_____Communication

_____Environmental cleanliness

_____Patient nonadherence with Contact Precautions

_____My work load

30.Please indicate your preferred resources for information regarding MRSA and infection control/prevention issues:	Infection Prevention Practitioner	☐Yes	☐No
	Infection Control Manual	☐Yes	☐No
	Manager	☐Yes	☐No
	Colleagues (Other staff)	☐Yes	☐No
	Internet	☐Yes	☐No
	Do my own search	☐Yes	☐No
31.Please indicate how you prefer to receive information on MRSA:	Class Room Presentation	☐Yes	☐No
	E-mail Communication	☐Yes	☐No
	Link to Web Site	☐Yes	☐No
	Information Flyers/Posters	☐Yes	☐No
	Staff Meeting Talks	☐Yes	☐No
	Other_____		

32.Please provide suggestions of ways to prevent transmission of MRSA:

33.Please suggest other barriers that prevent implementing isolation precautions or appropriate hand hygiene:

APPENDIX C: INTERVIEW SURVEY

MRSA Knowledge, Perceptions, and Practices Interview Survey

MRSA Study Qualitative Interview Questions

PIN: **I000** Date: __/__/__

_____

_

1. **Confirm you have direct contact with patients or enter patient areas?**
   ☐Yes **If you do not enter patient areas or have direct contact, do not continue.**

2. **Age**: ☐<18 ☐18- 25 ☐26-35 ☐36-45 ☐46-55 ☐56 or older

3. **Gender**: ☐Male ☐Female

4. **Education (Highest level completed)**: ☐MD ☐Doctorate ☐Masters ☐Bachelors ☐Diploma/Certificate ☐Associates ☐High School or GED ☐ Less than High School ☐Other:____

5. **Discipline/Department:** ☐Medical Doctor ☐Physician Assistant ☐Nurse Practitioner ☐Registered Nurse ☐Certified Nursing Assistant/Technician ☐Licensed Practical Nurse ☐Other nursing staff ☐Social Services ☐Cardio-Pulmonary ☐Laboratory ☐Medical Imaging ☐Pharmacist/Pharmacy ☐Physical Therapy ☐Speech Therapy ☐Occupational Therapy ☐Food Services ☐Engineering and Security ☐Environmental Services ☐Patient Registration ☐Other (Specify) _____

6. **Total Years in current Health Care Profession (include other hospitals)**: _____

7. **Hours worked per week at this hospital status?** ☐Full-Time ☐Part-time ☐PRN

8. **Please tell me how you feel MRSA affects you as a healthcare worker?**
   _____
   _____
   _____

9. **Please provide suggestions of ways to prevent transmission of MRSA:**
   _____
   _____
   _____

10. **We know that isolation precautions and appropriate hand hygiene prevent transmission of bacteria, including MRSA. How are you challenged in your work task when you have to enter an isolation room?**
    _____
    _____
    _____

11. **Please suggest other barriers that prevent implementing isolation precautions or appropriate hand hygiene.**
    _____
    _____

REFERENCES

Afif, W., Huor, P., Brassard, P., & Loo, V. G. (2002). Compliance with methicillin-resistant *Staphylococcus aureus* precautions in a teaching hospital. *American Journal of Infection Control*, *30*(7), 430–433.

Albrich, W. C., & Harbarth, S. (2008). Health-care workers: Source, vector, or victim of MRSA? *The Lancet Infectious Diseases*, *8*(5), 289–301. doi:10.1016/S1473-3099(08)70097-5

Almuneef, M. A., Baltimore, R. S., Farrel, P. A., Reagan-Cirincione, P., & Dembry, L. M. (2001). Molecular typing demonstrating transmission of gram-negative rods in a neonatal intensive care unit in the absence of a recognized epidemic. *Clinical Infectious Diseases*, *32*(2), 220 –227. doi:10.1086/318477

Askarian, M., Aramesh, K., & Palenik, C. J. (2006). Knowledge, attitude, and practice toward contact isolation precautions among medical students in Shiraz, Iran. *American Journal of Infection Control*, *34*(9), 593–596. doi:10.1016/j.ajic.2006.03.005

Askarian, M., Shiraly, R., Aramesh, K., & McLaws, M. (2006). Knowledge, attitude, and practices regarding contact precautions among Iranian physicians. *Infection Control and Hospital Epidemiology*, *27*(8), 868–872.

Askarian, M., Shiraly, R., & McLaws, M.-L. (2005). Knowledge, attitudes, and practices of contact precautions among Iranian nurses. *American Journal of Infection Control*, *33*(8), 486–488. doi:10.1016/j.ajic.2005.06.001

Association for Professionals in Infection Control and Epidemiology. (2010). Guide to the elimination of methicillin-resistant *Staphylococcus aureus* (MRSA) transmission in hospital settings. APIC. Retrieved from http://www.apic.org/Resource_/EliminationGuideForm/631fcd91-8773-4067-9f85-ab2a5b157eab/File/MRSA-elimination-guide-2010.pdf

Austin, L. T., Ahmad, F., McNally, M.-J., & Stewart, D. E. (2002). Breast and cervical cancer screening in Hispanic women: A literature review using the health belief model. *Women's Health Issues*, *12*(3), 122–128. doi:10.1016/S1049-3867(02)00132-9

Backman, C., Zoutman, D. E., & Marck, P. B. (2008). An integrative review of the current evidence on the relationship between hand hygiene interventions and the incidence of health care–associated infections. *American Journal of Infection Control*, *36*(5), 333–348. doi:10.1016/j.ajic.2007.08.007

Badran, I. (1995). Knowledge, attitudes and practice the three pillars of excellence and wisdom: a place in the medical profession. *Eastern Mediterranean Health Journal*, *1*(1), 8–16.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191–215. doi:10.1037/0033-295X.84.2.191

Bearman, G., Rosato, A. E., Duane, T. M., Elam, K., Sanogo, K., Haner, C., … Edmond, M. B. (2010). Trial of universal gloving with emollient-impregnated gloves to promote skin health and prevent the transmission of multidrug-resistant organisms in a surgical intensive care unit. *Infection Control and Hospital Epidemiology*, *31*(5), 491–497.

Becker, M. H., Haefner, D. P., Kasl, S. V., Kirscht, J. P., Maiman, L. A., & Rosenstock, I. M. (1977). Selected psychosocial models and correlates of individual health-related behaviors. *Medical Care*, *15*(5 SUPPL), 27–46.

Ben-David, D., Mermel, L. A., & Parenteau, S. (2008). Methicillin-resistant *Staphylococcus aureus* transmission: The possible importance of unrecognized health care worker carriage. *American Journal of Infection Control*, *36*(2), 93–97. doi:10.1016/j.ajic.2007.05.013

Berhe, M., Edmond, M. B., & Bearman, G. M. L. (2005). Practices and an assessment of health care workers' perceptions of compliance with infection control knowledge of nosocomial infections. *American Journal of Infection Control*, *33*(1), 55–57. doi:10.1016/j.ajic.2004.07.011

Bernard, H., Fischer, R., Mikolajczyk, R. T., & Wildner, M. (2009). Nurses' contacts and potential for infectious disease transmission. *Emerg Infect Dis [serial on the Internet]*, *15*(9), 1438–1444. doi:10.3201/eid1509.081475

Bhalla, A., Pultz, N. J., Gries, D. M., Ray, A. J., Eckstein, E. C., David C. Aron, M., & Donskey, C. J. (2004). Acquisition of nosocomial pathogens on hands after contact with environmental surfaces near hospitalized patients. *Infection Control and Hospital Epidemiology*, *25*(2), 164–167.

Bischoff, W., Reynolds, T., Sessler, C., Edmond, M., & Wenzel, R. (2000). Handwashing compliance by health care workers: The impact of introducing an accessible, alcohol-based hand antiseptic. *Archives of Internal Medicine*, *160*(7), 1017–1021.

Bland, J. M., & Altman, D. G. (1997). Cronbach's alpha. *BMJ (Clinical Research Ed.)*, *314*(7080), 572–572.

Blegen, M., Goode, C., Spetz, J., Vaughn, T., & Park, S. (2011). Nurse staffing effects on patient outcomes; Safety-net and non-safety-net hospitals. *Medical Care*, *49*(4), 406–414.

Boyce, J. M., & Pittet, D. (2002). Centers for Disease Control and Prevention. Guideline for hand hygiene in health-care settings: Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. *Morbidity and Mortality Weekly Report*, *51*(No. RR-16), 1–44.

Brady, R. R. W., McDermott, C., Cameron, F., Graham, C., & Gibb, A. P. (2009). UK healthcare workers' knowledge of meticillin-resistant *Staphylococcus aureus* practice guidelines; a questionnaire study. *Journal of Hospital Infection*, *73*(3), 264–270. doi:10.1016/j.jhin.2009.07.020

Brinsley, K., Sinkowitz-Cochran, R., Cardo, D., & the CDC Campaign to Prevent Antimicrobial Resistance Team. (2005b). An assessment of issues surrounding implementation of the Campaign to Prevent Antimicrobial Resistance in Healthcare Settings. *American Journal of Infection Control*, *33*(7), 402–409. doi:10.1016/j.ajic.2005.05.007

Brinsley, K., Sinkowitz-Cochran, R., Cardo, D., & The CDC Campaign to Prevent AR Team. (2004). Motivating physicians to prevent antimicrobial resistance in hospitalized children using the Health Belief Model as a framework. *American Journal of Infection Control*, *32*(3), E82–E83. doi:10.1016/j.ajic.2004.04.123

Brinsley, K., Sinkowitz-Cochran, R. L., Cardo, D. M., & The CDC Campaign to Prevent Antimicrobial Resistance Team. (2005a). Assessing motivation for physicians to prevent antimicrobial resistance in hospitalized children using the Health Belief Model as a framework. *American Journal of Infection Control*, *33*(3), 175–181. doi:10.1016/j.ajic.2004.12.004

Brinsley-Rainisch, K. J., Cochran, R. L., Bush-Knapp, M., Pearson, M. L., & Get Smart: Know When Antibiotics Work Team. (2006). The general public's awareness knowledge, and perceptions of "staph" - with a focus on community-associated methicillin-resistant *Staphylococcus aureus*. *American Journal of Infection Control*, *35*(6), 425–426. doi:10.1016/j.ajic.2006.12.010

Burkitt, K., Sinkowitz-Cochran, R., Obrosky, D., Cuerdon, T., Miller, L., Jain, R., … Fine, M. (2010). Survey of employee knowledge and attitudes before and after a multicenter Veterans' Administration quality improvement initiative to reduce nosocomial methicillin-resistant *Staphylococcus aureus* infections. *American Journal of Infection Control*, *38*(4), 274–282.

Burnett, E. (2009). Perceptions, attitudes, and behavior towards patient hand hygiene. *American Journal of Infection Control*, *37*(8), 638–642. doi:10.1016/j.ajic.2009.04.281

Bush-Knapp, M. E., Brinsley-Rainisch, K. J., Lawton-Ciccarone, R. M., Sinkowitz-Cochran, R. L., Dressler, D. D., Budnitz, T., & Williams, M. V. (2007). Spreading the word, not the infection: Reaching hospitalists about the prevention of antimicrobial resistance. *American Journal of Infection Control*, *35*(10), 656–661. doi:10.1016/j.ajic.2007.03.006

Bush-Knapp, M. E., Budnitz, T., Lawton-Ciccarone, R. M., Sinkowitz-Cochran, R. L., Brinsley-Rainisch, K. J., Dressler, D. D., & Williams, M. V. (2007). Impact of Society of Hospital Medicine workshops on hospitalists' knowledge and perceptions of health care–associated infections and antimicrobial resistance. *Journal of Hospital Medicine*, *2*(4), 268–273. doi:10.1002/jhm.223

Calfee, D. P., Durbin, L. J., Germanson, T.P., Toney, D. M., Smith, E. B., & Farr, B. M. (2003). Spread of methicillin-resistant *Staphylococcus aureus* (MRSA) among household contacts of individuals with nosocomially acquired MRSA. *Infection Control and Hospital Epidemiology*, *24*(6), 422–426.

Carboneau, C., Benge, E., Jaco, M. T., & Robinson, M. (2010). A Lean Six Sigma team increases hand hygiene compliance and reduces hospital-acquired MRSA infections by 51%. *Journal for Healthcare Quality*, *32*(4), 61–70. doi:10.1111/j.1945-1474.2009.00074.x

Centers for Disease Control and Prevention. (2010b). 2009 H1N1 Flu. Retrieved from http://www.cdc.gov/h1n1flu/

Centers for Disease Control and Prevention. (2010c). Interim Results: Influenza A (H1N1) 2009 monovalent and seasonal influenza vaccination coverage among health-care personnel --- United States, August 2009--January 2010. Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5912a1.htm

Centers for Disease Control and Prevention. (2011a). Final estimates for 2009–10 seasonal Influenza and Influenza A (H1N1) 2009 monovalent vaccination

coverage – United States, August 2009 through May, 2010. Retrieved from http://www.cdc.gov/flu/professionals/vaccination/coverage_0910estimates.htm

Centers for Disease Control and Prevention. (2010a). Definition of MRSA. Retrieved from http://www.cdc.gov/mrsa/definition/index.html

Chambers, H. F., & DeLeo, F. R. (2009). Waves of resistance: *Staphylococcus aureus* in the antibiotic era. *Nat Rev Micro*, *7*(9), 629–641. doi:10.1038/nrmicro2200

Champion, V., & Skinner, C. (2008). The health belief model [DX reader version]. In *Health behavior and health education: Theory, research, and practice* (4th ed., pp. 45–65). San Francisco, CA: Jossey-Bass. Retrieved from http://www.ihepsa.com/files/HB%20&%20HE-%20Glanz%20Book.pdf

Cheng, V. C. C., Tai, J. W. M., Chan, W. M., Lau, E. H. Y., Chan, J. F. W., To, K. K. W., … Yuen, K. Y. (2010). Sequential introduction of single room isolation and hand hygiene campaign in the control of methicillin-resistant *Staphylococcus aureus* in intensive care unit. *BMC Infectious Diseases*, *10*, 263.

Christiaens, G., Barbier, C., Mutsers, J., Warnotte, J., De Mol, P., & Bouffioux, C. (2006). Hand hygiene: First measure to control nosocomial infection. *Revue Médicale De Liège*, *61*(1), 31–36.

Cimiotti, J. P., Aiken, L. H., Sloane, D. M., & Wu, E. S. (2012). Nurse staffing, burnout, and health care–associated infection. *American Journal of Infection Control*, *40*(6), 486–490. doi:10.1016/j.ajic.2012.02.029

Clock, S., Cohen, B., Behta, M., Ross, B., & Larson, E. (2010). Contact precautions for multidrug-resistant organisms: Current recommendations and actual practice. *American Journal of Infection Control*, *38*(2), 105–111. doi:10.1016/j.ajic.2009.08.008

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (Second.). New York: Lawrence Erlbaum Associates.

Cromer, A. L., Hutsell, S. O., Latham, S. C., Bryant, K. G., Wacker, B. B., Smith, S. A., … Carney, M. C. (2004). Impact of implementing a method of feedback and accountability related to contact precautions compliance. *American Journal of Infection Control*, *32*(8), 451–455. doi:10.1016/j.ajic.2004.06.003

Cromer, A. L., Latham, S. C., Bryant, K. G., Hutsell, S., Gansauer, L., Bendyk, H. A., … Carney, M. C. (2008). Monitoring and feedback of hand hygiene compliance and the impact on facility-acquired methicillin-resistant *Staphylococcus aureus*.

American Journal of Infection Control, *36*(9), 672–677. doi:10.1016/j.ajic.2007.12.006

Cruz, E., Pimenta, F., Hayashida, M., Eidt, M., & Gir, E. (2011). *Staphylococcus aureus* detection in the mouth of housekeepers. *Latino-Am. Enfermagem [online*, *19*(1), 90–96. doi:org/10.1590/S0104-11692011000100013

Cummings, K. L., Anderson, D. J., & Kaye, K. S. (2010). Hand hygiene noncompliance and the cost of hospital-acquired methicillin-resistant *Staphylococcus aureus* infection. *Infection Control and Hospital Epidemiology*, *31*(4), 357–364.

Da Silva, A. M., De Carvalho, M. J., Da Silva Canini, S. R. M., De Almeida Cruz, E. D., Simões, C. L. A. P., & Gir, E. (2010). Methicillin resistant *Staphylococcus aureus*: Knowledge and factors related to the nursing teams adherence to preventive measures. *Revista Latino-Americana De Enfermagem*, *18*(3), 346–351.

Dancer, S. J. (2008). Importance of the environment in meticillin-resistant *Staphylococcus aureus* acquisition: The case for hospital cleaning. *Lancet Infectious Diseases*, *8*(2), 101–113.

De Wandel, D., Maes, L., Labeau, S., Vereecken, C., & Blot, S. (2010). Behavioral determinants of hand hygiene compliance in intensive care units. *American Journal of Critical Care*, *19*(3), 230–239. doi:10.4037/ajcc2010892

Department of Health and Human Services. (2010). *Progress Towards Eliminating Healthcare-Associated Infections*. Retrieved from http://www.hhs.gov/ash/initiatives/hai/actionplan/monitoring_progress.pdf

Devine, J., Cooke, R. P. D., & Wright, E. P. (2001). Is methicillin-resistant *Staphylococcus aureus* (MRSA) contamination of ward-based computer terminals a surrogate marker for nococomial MRSA transmission and handwashing compliance? *Journal of Hospital Infection*, *48*(1), 72–75. doi:10.1053/jhin.2001.0955

Dietze, B., Rath, A., Wendt, C., & Martiny, H. (2001). Survival of MRSA on sterile goods packaging. *Journal of Hospital Infection*, *49*(4), 255–261. doi:10.1053/jhin.2001.1094

Duckro, A. N., Blom, D. W., Lyle, E. A., Weinstein, R. A., & Hayden, M. K. (2005). Transfer of vancomycin-resistant enterococci via health care worker hands. *Archives of Internal Medicine*, *165*(3), 302–307. doi:10.1001/archinte.165.3.302

Easton, P. M., Marwick, C. A., Williams, F. L. R., Stringer, K., McCowan, C., Davey, P., & Nathwani, D. (2009). A survey of public knowledge and perceptions of

methicillin-resistant *Staphylococcus aureus*. *Journal of Antimicrobial Chemotherapy*, *63*(1), 209–214. doi:10.1093/jac/dkn447

Easton, P. M., Sarma, A., Williams, F. L. R., Marwick, C. A., Phillips, G., & Nathwani, D. (2007). Infection control and management of MRSA: Assessing the knowledge of staff in an acute hospital setting. *The Journal of Hospital Infection*, *66*(1), 29–33.

Ebnöther, C., Tanner, B., Schmid, F., La Rocca, V., Heinzer, I., & Bregenzer, T. (2008). Impact of an infection control program on the prevalence of nosocomial infections at a tertiary care center in Switzerland. *Infection Control and Hospital Epidemiology*, *29*(1), 38–43.

Efstatiou, G., Papastavrou, E., Raftopoulos, V., & Merkouris, A. (2011). Factors influencing nurses' compliance with Standard Precautions in order to avoid occupational exposure to microorganisms: A focus group study. *BMC Nursing*, *10*(1), 1–12. doi:10.1186/1472-6955-10-1

Eldridge, N. E., Woods, S. S., Bonello, R. S., Clutter, K., Ellingson, L., Harris, M. A., … Wright, S. M. (2006). Using the Six Sigma process to implement the Centers for Disease Control and Prevention Guideline for Hand Hygiene in 4 intensive care units. *Journal of General Internal Medicine*, *21*, S35–S42. doi:Article

Elie-Turenne, M., Fernandes, H., Mediavilla, J. R., Rosenthal, M., Mathema, B., Singh, A., … Deitch, E. A. (2010). Prevalence and characteristics of *Staphylococcus aureus* colonization among healthcare professionals in an urban teaching hospital. *Infection Control and Hospital Epidemiology*, *31*(6), 574–580.

Elixhauser, A., Friedman, B., & Stranges, E. (2011). *Septicemia in U.S. Hospitals, 2009* (HCUP Statistical Brief #122). Rockville, MD: Agency for Healthcare Research and Quality. Retrieved from http://www.hcup-us.ahrq.gov/reports/statbriefs/sb122.pdf

Elixhauser, A., & Steiner, C. (2007). *Infections with methicillin-resistant Staphylococcus aureus (MRSA) in U.S. hospitals, 1993-2005*. Agency for Healthcare Research and Quality, Rockville, MD: HCUP Statistical Brief #35. Retrieved from http://www.hcup-us.ahrq.gov/reports/statbriefs/sb35.pdf

Engum, S. A., & Jeffries, P. R. (2012). Interdisciplinary collisions: Bringing healthcare professionals together. *Collegian (Royal College Of Nursing, Australia)*, *19*(3), 145–151.

Erasmus, V., Brouwer, W., Beeck, E. F. van, Oenema, A., Daha, T. J., Richardus, J. H., … Brug, J. (2009). A qualitative exploration of reasons for poor hand hygiene

among hospital workers: Lack of positive role models and of convincing evidence that hand hygiene prevents cross-infection. *Infection Control and Hospital Epidemiology*, *30*(5), 415–419.

Erasmus, V., Daha, T. J., Brug, H., Richardus, J. H., Behrendt, M. D., Vos, M. C., & van Beeck, E. F. (2010). Systematic review of studies on compliance with hand hygiene guidelines in hospital care. *Infection Control and Hospital Epidemiology*, *31*(3), 283–294.

Esolen, L. M., Kilheeney, K. L., Merkle, R. E., & Bothe, A. (2011). An alternate approach to improving healthcare worker influenza vaccination rates. *Infection Control and Hospital Epidemiology*, *32*(7), 703–705.

Eveillard, M, Tramier, B., Schmit, J., Lescure, F., Biendo, M., Canarelli, B., … Thomas, D. (2001). Evaluation of the contribution of isolation precautions in prevention and control of multi-resistant bacteria in a teaching hospital. *Journal of Hospital Infection*, *47*(2), 116–124.

Eveillard, M., Lancien, E., deLassence, A., Branger, C., Barnaud, G., Benlolo, J.-A., & Joly-Guillou, M.-L. (2006). Impact of the reinforcement of a methicillin-resistant *Staphylococcus aureus* control programme: A 3-year evaluation by several indicators in a French university hospital. *European Journal of Epidemiology*, *21*(7), 551–558.

Eveillard, M., Martin, Y., Hidri, N., Boussougant, Y., & Joly-Guillou, M. (2004). Carriage of methicillin-resistant *Staphylococcus aureus* among hospital employees: Prevalence, duration, and transmission to households. *Infection Control and Hospital Epidemiology*, *25*(2), 114–120.

Faires, M. C., Pearl, D. L., Ciccotelli, W. A., Straus, K., Zinken, G., Berke, O., … Weese, J. S. (2012). A prospective study to examine the epidemiology of methicillin-resistant *Staphylococcus aureus* and *Clostridium difficile* contamination in the general environment of three community hospitals in southern Ontario, Canada. *BMC Infectious Diseases*, *12*, 290–290. doi:10.1186/1471-2334-12-290

Farr, B., & Bellingan, G. (2004). Pro/con debate: Isolation precautions for all intensive care unit patients with methicillin-resistant *Staphylococcus aureus* colonization are essential. *Critical Care*, *8*(3), 153–156.

Frei, C. R., Makos, B. R., Daniels, K. R., & Oramasionwu, C. U. (2010). Emergence of community-acquired methicillin-resistant *Staphylococcus aureus* skin and soft tissue infections as a common cause of hospitalization in United States children. *Journal Of Pediatric Surgery*, *45*(10), 1967–1974.

Gershon, R. R. ., Karkashian, C. D., Grosch, J. W., Murphy, L. R., Escamilla-Cejudo, A., Flanagan, P. A., … Martin, L. (2000). Hospital safety climate and its relationship with safe work practices and workplace exposure incidents. *American Journal of Infection Control*, *28*(3), 211–221. doi:10.1067/mic.2000.105288

Gilbert, K., Stafford, C., Crosby, K., Fleming, E., & Gaynes, R. (2010). Does hand hygiene compliance among health care workers change when patients are in contact precaution rooms in ICUs? *American Journal of Infection Control*, *38*(7), 515–517. doi:10.1016/j.ajic.2009.11.005

Gill, J., Kumar, R., Todd, J., & Wiskin, C. (2006). Methicillin-resistant *Staphylococcus aureus:* Awareness and perceptions. *Journal of Hospital Infection*, *62*(3), 333–337.

Girou, E., Loyeau, S., Legrand, P., Oppein, F., & Brun-Buisson, C. (2002). Efficacy of handrubbing with alcohol based solution versus standard handwashing with antiseptic soap: Randomised clinical trial. *British Medical Journal*, *325*(7360), 362–365.

Glanz, K., Rimer, B. K., & Viswanath, K. (2008). *Health behavior and health education: Theory, research, and practice* (4th ed.). San Francisco, CA: Jossey-Bass.

Grant, A. M., & Hofmann, D. A. (2011). It's not all about me. *Psychological Science*, *22*(12), 1494 –1499. doi:10.1177/0956797611419172

Grayson, M. L., Jarvie, L., Martin, R., Johnson, P., Jodoin, M., McMullan, C., … on behalf of the Victorian Quality Council's Hand Hygiene Study Group and Hand Hygiene Statewide Roll-out Group. (2008). Significant reductions in methicillin-resistant *Staphylococcus aureus* bacteraemia and clinical isolates associated with a multisite, hand hygiene culture-change program and subsequent successful statewide roll-out. *Medical Journal of Australia*, *188*(11), 633–640.

Griffith, C. J., Malik, R., Cooper, R. A., Looker, N., & Michaels, B. (2003). Environmental surface cleanliness and the potential for contamination during handwashing. *American Journal of Infection Control*, *31*(2), 93–96. doi:10.1067/mic.2003.62

Haas, J. P, & Larson, E. L. (2007). Measurement of compliance with hand hygiene. *The Journal Of Hospital Infection*, *66*(1), 6–14.

Haas, J. P, & Larson, E. L. (2008). Impact of wearable alcohol gel dispensers on hand hygiene in an emergency department. *Academic Emergency Medicine*, *15*(4), 393–396.

Halcomb, E. J., Fernandez, R., Griffiths, R., Newton, P., & Hickman, L. (2008). The infection control management of MRSA in acute care. *International Journal of Evidence-Based Healthcare*, *6*(4), 440–467.

Halcomb, E. J., Griffiths, R., & Fernandez, R. (2008). The role of patient isolation and compliance with isolation practices in the control of nosocomial MRSA in acute care. *International Journal of Evidence-Based Healthcare*, *6*(2), 206–224. doi:10.1111/j.1744-1609.2008.00089.x

Harbarth, S., Pittet, D., Grady, L., Zawacki, A., Potter-Bynoe, G., Samore, M. H., & Goldmann, D. A. (2002). Interventional study to evaluate the impact of an alcohol-based hand gel in improving hand hygiene compliance. *The Pediatric Infectious Disease Journal*, *21*(6), 489–495.

Harrington, G., Watson, K., Bailey, M., Land, G., Borrell, S., Houston, L., … Spelman, D. (2007). Reduction in hospitalwide incidence of infection or colonization with methicillin-resistant *Staphylococcus aureus* with use of antimicrobial hand-hygiene gel and statistical process control charts. *Infection Control and Hospital Epidemiology*, *28*(7), 837–844.

Hayden, J., & Paterson, W. (2009). Health Belief Model. In *Introduction to health behavior theory* (pp. 32–44). Wayne University, NJ: Jones and Bartlett. Retrieved from http://www.jblearning.com/samples/0763743836/Chapter%204.pdf

Hidron, A. I., Edwards, J. R., Patel, J., Horan, T. C., Sievert, D. M., Pollock, D. A., & Fridkin, S. K. (2008). Antimicrobial-resistance pathogens associated with healthcare-associated infections: Annual summary of data reported to the National Healthcare Safety Network at the Centers for Disease Control and Prevention, 2006-2007. *Infection Control and Hospital Epidemiology*, *29*, 996–1011. doi:10.1086/591861

Hidron, A. I., Kourbatova, E. V., Halvosa, J. S., Terrell, B. J., McDougal, L. K., Tenover, F. C., … King, M. D. (2005). Risk Factors for colonization with methicillin-resistant *Staphylococcus aureus* (MRSA) in patients admitted to an urban hospital: Emergence of community-associated MRSA nasal carriage. *Clinical Infectious Diseases*, *41*(2), 159–166.

Hidron, A. I., Low, C. E., Honig, E. G., & Blumberg, H. M. (2009). Emergence of community-acquired meticillin-resistant *Staphylococcus aureus* strain USA300 as a cause of necrotising community-onset pneumonia. *The Lancet Infectious Diseases*, *9*(6), 384–392. doi:10.1016/S1473-3099(09)70133-1

Hsieh, H.-F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research*, *15*(9), 1277–1288.

Hugonnet, S, Chevrolet, J., & Pittet, D. (2007). The effect of workload on infection risk in critically ill patients. *Critical Care Medicine*, *35*(1), 76–81.

Hugonnet, Stéphane, Perneger, T. V., & Pittet, D. (2002). Alcohol-based handrub improves compliance with hand hygiene in intensive care units. *Archives of Internal Medicine*, *162*(9), 1037–1043.

Hugonnet, Stéphane, Uçkay, I., & Pittet, D. (2007). Staffing level: a determinant of late-onset ventilator-associated pneumonia. *Critical Care (London, England)*, *11*(4), R80–R80.

Huskins, W. C., Huckabee, C. M., O'Grady, N. P., Murray, P., Kopetskie, H., Zimmer, L., … Goldmann, D. A. (2011). Intervention to reduce transmission of resistant bacteria in intensive care. *New England Journal of Medicine*, *364*(15), 1407–1418. doi:10.1056/NEJMoa1000373

Institute for Healthcare Improvement. (2008). Getting Started Kit: Prevent Pressure Ulcers. How-to Guide. 5 Million Lives Campaign. Cambridge, MA: Institute for Healthcare Improvement. Retrieved from http://www.ihi.org

Jang, J., Wu, S., Kirzner, D., Moore, C., Youssef, G., Tong, A., … Allison McGeer, M. (2010). Focus group study of hand hygiene practice among healthcare workers in a teaching hospital in Toronto, Canada. *Infection Control and Hospital Epidemiology*, *31*(2), 144–150.

Janz, N. K., & Becker, M. H. (1984). The Health Belief Model: A decade later. *Health Education & Behavior*, *11*(1), 1 –47. doi:10.1177/109019818401100101

Jarvis, W. R., Jarvis, A. A., & Chinn, R. Y. (2012). National prevalence of methicillin-resistant *Staphylococcus aureus* in inpatients at United States health care facilities, 2010. *American Journal of Infection Control*, *40*(3), 194–200.

Jennings-Sanders, A., & Jury, L. (2010). Assessing methicillin-resistant *Staphylococcus aureus* knowledge among nursing students. *Nurse Education Today*, *30*(8), 789–793. doi:10.1016/j.nedt.2010.02.001

Johnson, P., Martin, R., Burrell, L., Grabsch, E., Kirsa, S., O'Keeffe, J., … Grayson, M. L. (2005). Efficacy of an alcohol/chlorhexidine hand hygiene program in a hospital with high rates of nosocomial methicillin-resistant *Staphylococcus aureus* (MRSA) infection. *Medical Journal of Australia*, *183*(10), 509–514.

Kaminski, A., Kammler, J., Wick, M., Muhr, G., & Kutscha-Lissberg, F. (2007). Transmission of methicillin-resistant *Staphylococcus aureus* among hospital staff

in a German trauma centre: A problem without a current solution? *The Journal of Bone and Joint Surgery. British Volume*, *89*(5), 642–645.

Karanfil, L. V., Bahner, J., Hovatter, J., & Thomas, W. L. (2011). Championing patient safety through mandatory influenza vaccination for all healthcare personnel and affiliated physicians. *Infection Control and Hospital Epidemiology*, *32*(4), 375–379.

Kassis, C., Hachem, R., Raad, I. I., Perego, C. A., Dvorak, T., Hulten, K. G., … Chemaly, R. F. (2011). Outbreak of community-acquired methicillin-resistant *Staphylococcus aureus* skin infections among health care workers in a cancer center. *American Journal of Infection Control*, *39*(2), 112–117. doi:10.1016/j.ajic.2010.04.220

Kim, P. W., Roghmann, M.-C., Perencevich, E. N., & Harris, A. D. (2003). Rates of hand disinfection associated with glove use, patient isolation, and changes between exposure to various body sites. *American Journal of Infection Control*, *31*(2), 97–103. doi:10.1067/mic.2003.32

Klevens, R. M., Edwards, J., Tenover, F. C., McDonald, L. C., Horan, T., & Gaynes, R. (2006). National Nosocomial Infections Surveillance System. Changes in the epidemiology of methicillin-resistant *Staphylococcus aureus* in intensive care units in US hospitals, 1992 - 2003. *Clinical Infectious Disease*, *43*, 387–8.

Klevens, R. M., Morrison, M. A., Nadle, J., Petit, S., Gershman, K., Ray, S., … for the Active Bacterial Core surveillance (ABCs) MRSA Investigators. (2007). Invasive methicillin-resistant *Staphylococcus aureus* infections in the United States. *Journal of the American Medical Association*, *298*(15), 1763 –1771. doi:10.1001/jama.298.15.1763

Koltes, L. (2009). Healthcare workers' attitudes, understanding and perceived risk of methicillin-resistant *Staphylococcus aureus* (D.N.P. dissertation). North Dakota State University, United States -- North Dakota. Retrieved from Retrieved July 7, 2011, from Dissertations & Theses: Full Text.(Publication No. AAT 3391580).

Korniewicz, D., & El-Masri, M. (2010). Exploring the factors associated with hand hygiene compliance of nurses during routine clinical practice. *Applied Nursing Research*, *23*(2), 86–90. doi:10.1016/j.apnr.2008.06.002

Kottler, S., Middleton, J. R., Perry, J., Weese, J. S., & Cohn, L. A. (2010). Prevalence of *Staphylococcus aureus* and methicillin-resistant *Staphylococcus aureus* carriage in three populations. *Journal of Veterinary Internal Medicine / American College of Veterinary Internal Medicine*, *24*(1), 132–139.

Lam, B. C. C., Lee, J., & Lau, Y. L. (2004). Hand hygiene practices in a neonatal intensive care unit: A multimodal intervention and impact on nosocomial infection. *Pediatrics*, *114*(5), e565 –e571. doi:10.1542/peds.2004-1107

Larson, E., Early, E., Cloonan, P., Sugrue, S., & Parides, M. (2000). An organizational climate intervention associated with increased handwashing and decreased nosocomial infections. *Behavioral Medicine*, *26*(1), 14–22.

Larson, E. L., Eke, P. I., & Laughon, B. E. (1986). Efficacy of alcohol-based hand rinses under frequent-use conditions. *Antimicrobial Agents and Chemotherapy*, *30*(4), 542 –544. doi:10.1128/AAC.30.4.542

Lee, A., Chalfine, A., Daikos, G. L., Garilli, S., Jovanovic, B., Lemmen, S., … Harbarth, S. (2011). Hand hygiene practices and adherence determinants in surgical wards across Europe and Israel: A multicenter observational study. *AJIC - American Journal of Infection Control*, *39*(6), 517–520.

Lee, T., Moore, C., Raboud, J., Muller, M., Green, K., Tong, A., … McGeer, A. (2009). Impact of a mandatory infection control education program on nosocomial acquisition of methicillin-resistant *Staphylococcus aureus*. *Infection Control & Hospital Epidemiology*, *30*(3), 249–256. doi:10.1086/596042

Levett-Jones, T., Gilligan, C., Lapkin, S., & Hoffman, K. (2012). Interprofessional education for the quality use of medicines: designing authentic multimedia learning resources. *Nurse Education Today*, *32*(8), 934–938. doi:10.1016/j.nedt.2011.10.013

Lines, L. (2006). A study of senior staff nurses' perceptions about MRSA. *Nursing Times*, *102*(15), 32–35.

Lucet, J. C., Rigaud, M.-P., Mentre, F., Kassis, N., Deblangy, C., Andremont, A., & Bouvet, E. (2002). Hand contamination before and after different hand hygiene techniques: A randomized clinical trial. *Journal of Hospital Infection*, *50*(4), 276–280. doi:10.1053/jhin.2002.1202

Lugg, G. R., & Ahmed, H. A. (2008). Nurses' perceptions of meticillin-resistant *Staphylococcus aureus*: Impacts on practice. *British Journal of Infection Control*, *9*(1), 8 –14. doi:10.1177/1469044607084969

Lukas, C., Engle, R., Holmes, S., Parker, V., Petzel, R., Seibert, M., … Sullivan, J. (2010). Strengthening organizations to implement evidence-based clinical practices. *Health Care Management Review*, *35*(3), 235–245. doi:10.1097/HMR.0b013e3181dde6a5

MacDonald, A., Dinah, F., MacKenzie, D., & Wilson, A. (2004). Performance feedback of hand hygiene, using alcohol gel as the skin decontaminant, reduces the number of inpatients newly affected by MRSA and antibiotic costs. *Journal of Hospital Infection*, *56*(1), 56–63. doi:10.1016/S0195-6701(03)00293-7

Manian, F., & Ponzillo, J. (2007). Compliance with routine use of gowns by healthcare workers (HCWs) and non-HCW visitors on entry into the rooms of patients under contact precautions. *Infection Control and Hospital Epidemiology*, *28*(3), 337–340.

Mathai, A. S., George, S. E., & Abraham, J. (2011). Efficacy of a multimodal intervention strategy in improving hand hygiene compliance in a tertiary level intensive care unit. *Indian Journal Of Critical Care Medicine*, *15*(1), 6–15.

Maury, E., Moussa, N., Lakermi, C., Barbut, F., & Offenstadt, G. (2006). Compliance of health care workers to hand hygiene: Awareness of being observed is important. *Intensive Care Medicine*, *32*, 2088–2089. doi:10.1007/s00134-006-0398-9

McBryde, E. S., Bradley, L. C., Whitby, M., & McElwain, D. L. S. (2004). An investigation of contact transmission of methicillin-resistant *Staphylococcus aureus*. *Journal of Hospital Infection*, *58*(2), 104–108.

McGuckin, M., Taylor, A., Martin, V., Porten, L., & Salcido, R. (2004). Evaluation of a patient education model for increasing hand hygiene compliance in an inpatient rehabilitation unit. *American Journal of Infection Control*, *32*(4), 235–238. doi:10.1016/j.ajic.2003.10.005

Mertler, C., & Vannatta, R. (2005). *Advanced and multivariate statistical methods* (Third.). Glendal, CA: Pyrczak Publishing.

Mertz, D., Dafoe, N., Walter, S., Brazil, K., & Loeb, M. (2010). Effect of a multifaceted intervention on adherence to hand hygiene among healthcare workers: A cluster-randomized trial. *Infection Control and Hospital Epidemiology*, *31*(11), 1170–1176. doi:10.1086/656592

Mikkelsen, J., Reime, M. H., & Harris, A. K. (2008). Nursing students' learning of managing cross-infections - Scenario-based simulation training versus study groups. *Nurse Education Today*, *28*(6), 664–671. doi:doi: DOI: 10.1016/j.nedt.2007.11.003

Morgan, D. J., Day, H. R., Furuno, J. P., Young, A., Johnson, J. K., Bradham, D. D., & Perencevich, E. N. (2010). Improving efficiency in active surveillance for methicillin-resistant *Staphylococcus aureus* or vancomycin-resistant enterococcus

at hospital admission. *Infection Control and Hospital Epidemiology*, *31*(12), 1230–1235.

Muto, C., Sistrom, B., & Farr, B. (2000). Hand hygiene rates unaffected by installation of dispensers of a rapidly acting hand antiseptic. *American Journal of Infection Control*, *28*(3), 273–276.

Neely, A. N., & Maley, M. P. (2000). Survival of enterococci and staphylococci on hospital fabrics and plastic. *Journal of Clinical Microbiology*, *38*(2), 724–726.

Nichols, A., & Badger, B. (2008). An investigation of the division between espoused and actual practice in infection control and of the knowledge sources that may underpin this division. *British Journal of Infection Control*, *9*(4), 11–15.

Nightingale, F. (1860). Notes on nursing. Retrieved March 3, 2013, from http://digital.library.upenn.edu/women/nightingale/nursing/nursing.html

O'Boyle, C., Henly, S., & Larson, E. (2001). Understanding adherence to hand hygiene recommendations: The theory of planned behavior. *American Journal of Infection Control*, *29*(6), 352–360.

Ohl, M., Schweizer, M., Graham, M., Heilmann, K., Boyken, L., & Diekema, D. (2012). Hospital privacy curtains are frequently and rapidly contaminated with potentially pathogenic bacteria. *American Journal of Infection Control*, *40*(10), 904–906. doi:10.1016/j.ajic.2011.12.017

Oie, S., Hosokawa, I., & Kamiya, A. (2002). Contamination of room door handles by methicillin-sensitive/methicillin-resistant *Staphylococcus aureus*. *Journal of Hospital Infection*, *51*(2), 140–143. doi:10.1053/jhin.2002.1221

Oliveira, A., Cardoso, C., & Mascarenhas, D. (2010). Contact precautions in intensive care units: Facilitating and inhibiting factors for professionals' adherence [Portuguese]. *Revista da Escola de Enfermagem da USP*, *44*(1), 161–165.

Oliver, D. G. S. (2005). Constraints and Opportunities with Interview Transcription: Towards Reflection in Qualitative Research. *Social Forces (University of North Carolina Press)*, *84*(2), 1273–1289.

Panlilio, A. L., Culver, D. H., Gaynes, R. P., Banerjee, S., Henderson, T. S., Tolson, J. S., & Martone, W. J. (1992). Methicillin-Resistant *Staphylococcus aureus* in U.S. Hospitals, 1975-1991. *Infection Control and Hospital Epidemiology*, *13*(10), 582–586.

Paterson, T. (2010). Generational considerations in providing critical care education. *Critical Care Nursing Quarterly*, *33*(1), 67–74. doi:10.1097/CNQ.0b013e3181c8dfa8

Phillips, P. S., Golagani, A. K., Malik, A., & Payne, F. B. (2010). A staff questionnaire study of MRSA infection on ENT and general surgical wards. *European Archives of Oto-Rhino-Laryngology*, *267*(9), 1455–1459.

Pittet, D, Simon, A., Hugonnet, S., Pessoa-Silva, C. L., Sauvan, V., & Perneger, T. V. (2004). Hand hygiene among physicians: Performance, beliefs, and perceptions. *Annals of Internal Medicine*, *141*(1), 1 –8.

Pittet, Didier. (2001). Improving adherence to hand hygiene practice: A multidisciplinary approach. *Emerging Infectious Diseases*, *7*(2), 234–240.

Pittet, Didier. (2004). The Lowbury lecture: Behaviour in infection control. *Journal of Hospital Infection*, *58*, 1–13. doi:10.1016/j.jhin.2004.06.002

Pittet, Didier, Hugonnet, S., Harbarth, S., Mourouga, P., Sauvan, V., Touveneau, S., & Perneger, T. V. (2000). Effectiveness of a hospital-wide programme to improve compliance with hand hygiene. *The Lancet*, *356*(9238), 1307–1312. doi:10.1016/S0140-6736(00)02814-2

Polit, D.F., & Beck, C. (2006). The content validity index: Are you sure you know what's being reported? Critique and recommendations. *Research in Nursing & Health*, *29*(5), 489–497.

Polit, D. F. (2010). *Statistics and Data Analysis for Nursing Research* (Second.). Saratoga Springs, NY: Humanalysis.

Polit, D. F., & Beck, C. T. (2008). *Nursing research: Principles and Methods* (8th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

Randle, J., Arthur, A., & Vaughan, N. (2010). Twenty-four-hour observational study of hospital hand hygiene compliance. *Journal of Hospital Infection*, *76*(3), 252–255. doi:10.1016/j.jhin.2010.06.027

Rohde, R. E., Rowder, C., Patterson, T., Redwine, G., Vásquez, B., & Carranco, E. (2012). Methicillin resistant *Staphylococcus aureus* (MRSA): An interim report of carriage and conversion rates in nursing students. *Clinical Laboratory Science*, *25*(2), 94–101.

Rohr, U., Kaminski, A., Wilhelm, M., Jurzik, L., Gatermann, S., & Muhr, G. (2009). Colonization of patients and contamination of the patients' environment by MRSA under conditions of single-room isolation. *International Journal of Hygiene and Environmental Health*, *212*(2), 209–215. doi:10.1016/j.ijheh.2008.05.003

Rosenstock, I., Strecher, V., & Becker, M. H. (1988). Social Learning Theory and the Health Belief Model. *Health Education Quarterly*, *15*(2), 175–183.

Rupp, M. E., Fitzgerald, T., Puumala, S., Anderson, J. R., Craig, R., Iwen, P. C., … Smith, V. (2008). Prospective, controlled, cross-over trial of alcohol-based hand gel in critical care units. *Infection Control and Hospital Epidemiology*, *29*(1), 8–15.

Saiman, L., Cronquist, A., Wu, F., Zhou, J., Rubenstein, D., Eisner, W., … Della-Latta, P. (2003). An outbreak of methicillin-resistant *Staphylococcus aureus* in a neonatal intensive care unit. *Infection Control and Hospital Epidemiology*, *24*(5), 317–321.

Sakamoto, F., Yamada, H., Suzuki, C., Sugiura, H., & Tokuda, Y. (2010). Increased use of alcohol-based hand sanitizers and successful eradication of methicillin-resistant *Staphylococcus aureus* from a neonatal intensive care unit: A multivariate time series analysis. *American Journal of Infection Control*, *38*(7), 529–534. doi:10.1016/j.ajic.2009.12.014

Salgado, C. D., & Farr, B. M. (2006). What proportion of hospital patients colonized with methicillin-resistant *Staphylococcus aureus* are identified by clinical microbiological cultures? *Infection Control and Hospital Epidemiology*, *27*(2), 116–121.

Sax, H., Uçkay, I., Richet, H., Allegranzi, B., & Pittet, D. (2007). Determinants of good adherence to hand hygiene among healthcare workers who have extensive exposure to hand hygiene campaigns. *Infection Control and Hospital Epidemiology*, *28*(11), 1267–1274.

Seaton, R. A., & Montazeri, A. H. (2006). Medical staff knowledge about MRSA colonization and infection in acute hospitals. *Journal of Hospital Infection*, *64*(3), 297–299. doi:10.1016/j.jhin.2006.06.023

Sexton, T., Clarke, P., O'Neill, E., Dillane, T., & Humphreys, H. (2006). Environmental reservoirs of methicillin-resistant *Staphylococcus aureus* in isolation rooms: Correlation with patient isolates and implications for hospital hygiene. *Journal of Hospital Infection*, *62*(2), 187–194. doi: 10.1016/j.jhin.2005.07.017

Sherertz, R., Bassetti, S., & Bassetti-Wyss, B. A. (2001). “Cloud” health-care workers, *7*(2), 241–244.

Shimokura, G., Weber, D. J., Miller, W. C., Wurtzel, H., & Alter, M. J. (2006). Factors associated with personal protection equipment use and hand hygiene among hemodialysis staff. *American Journal of Infection Control*, *34*(3), 100–107. doi:10.1016/j.ajic.2005.08.012

Siegel, J., Rhinehart, E., Jackson, M., Chiarella, L., & Healthcare Infection Control Practices Advisory Committee. (2006). Management of multidrug-resistant organism 2006. Centers for Disease Control and Prevention. Retrieved from http://www.cdc.gov/ncidod/dhqp/pdf/ar/MDROGuideline2006.pdf

Silva, A. M. da, Carvalho, M. J. de, Canini, S. R. M. da S., Cruz, E. D. de A., Simões, C. L. A. P., & Gir, E. (2010). Methicillin Resistant *Staphylococcus aureus*: Knowledge and factors related to the nursing team’s adherence to preventive measures. *Revista Latino-Americana de Enfermagem*, *18*(3), 346–351.

Snyder, G., Thorn, K., Furuno, J. P., Perencevich, E. N., Roghmann, M.-C., Strauss, S., … Harris, A. D. (2008). Detection of methicillin-resistant *Staphylococcus aureus* and vancomycin-resistant enterococci on the gowns and gloves of healthcare workers. *Infection Control and Hospital Epidemiology*, *29*(7), 583–589. doi:10.1086/588701

Stiefel, U., Cadnum, J. L., Eckstein, B. C., Guerrero, D. M., Tima, M. A., & Donskey, C. J. (2011). Contamination of hands with methicillin-resistant *Staphylococcus aureus* after contact with environmental surfaces and after contact with the skin of colonized patients. *Infection Control and Hospital Epidemiology*, *32*(2), 185–187.

Stretcher, V., & Rosenstock, I. (1997). The Health Belief Model. In *Health Behavior and Health Education: Theory, Research, and Practice* (2nd ed., pp. 41–59). San Francisco: Jossey-Bass.

Sujijantararat, R., Booth, R., & Davis, L. (2005). Nosocomial urinary tract infection: nursing-sensitive quality indicator in a Thai hospital. *Journal of Nursing Care Quality*, *20*(2), 134–139.

The Joint Commission. (2012, January). Hospital National Patient Safety Goals 2012. Retrieved from http://www.jointcommission.org/assets/1/6/NPSG_Chapter_Jan2012_HAP.pdf

Trigg, D., Timmons, S., & Pynegar, C. (2008). An audit of healthcare workers’ knowledge of meticillin resistant *Staphylococcus aureus* (MRSA) against current infection control standards. *British Journal of Infection Control*, *9*(1), 30–33.

U.S. Department of Health and Human Services. (2011, September). Healthcare-Associated Infection (HAI). U.S. Department of Health and Human Services. Retrieved from http://www.hhs.gov/ash/initiatives/hai

Van Gemert-Pijnen, J., Hendrix, M. G. R., van der Palen, J., & Schellens, P. J. (2005). Performance of methicillin-resistant *Staphylococcus aureus* protocols in Dutch hospitals. *American Journal of Infection Control*, *33*(7), 377–384. doi:10.1016/j.ajic.2004.10.009

Venkatesh, A. K., Lankford, M. G., Rooney, D. M., Blachford, T., Watts, C. M., & Noskin, G. A. (2008). Use of electronic alerts to enhance hand hygiene compliance and decrease transmission of vancomycin-resistant Enterococcus in a hematology unit. *American Journal of Infection Control*, *36*(3), 199–205. doi:10.1016/j.ajic.2007.11.005

Vernaz, N., Sax, H., Pittet, D., Bonnabry, P., Schrenzel, J., & Harbarth, S. (2008). Temporal effects of antibiotic use and hand rub consumption on the incidence of MRSA and *Clostridium difficile*. *The Journal Of Antimicrobial Chemotherapy*, *62*(3), 601–607.

Vonberg, R., Stamm-Balderjahn, S., Hansen, S., Zuschneid, I., Rüden, H., Behnke, M., & Gastmeier, P. (2006). How often do asymptomatic healthcare workers cause methicillin-resistant *Staphylococcus aureus* outbreaks? A Systematic Evaluation. *Infection Control and Hospital Epidemiology*, *27*(10), 1123–1127.

Wagenvoort, J. H. T., Sluijsmans, W., & Penders, R. J. R. (2000). Better environmental survival of outbreak vs. sporadic MRSA isolates. *Journal of Hospital Infection*, *45*(3), 231–234. doi:10.1053/jhin.2000.0757

Weese, J. S., Willey, B., McGeer, A., Kreiswirth, B., Innis, B., & Low, D. (2006). Suspected transmission of methicillin-resistant *Staphylococcus aureus* between domestic pets and humans in veterinary clinics and in the household. *Veterinary Microbiology*, *115*(1-3), 148–155.

Weinstein, R. A., Stone, P. W., Pogorzelska, M., Kunches, L., & Hirschhorn, L. R. (2008). Hospital staffing and health care–associated infections: A systematic review of the literature. *Clinical Infectious Diseases*, *47*(7), 937 –944. doi:10.1086/591696

Wenger, E. (2000). Communities of practice: The structure of knowledge stewarding. In *Knowledge horizons: The present and the promise of knowledge management* (pp. 205–225). Woburn, MA: Butterworth-Heinemann.

Wertheim, H. F., Melles, D. C., Vos, M. C., van Leeuwen, W., van Belkum, A., Verbrugh, H. A., & Nouwen, J. L. (2005). The role of nasal carriage in *Staphylococcus aureus* infections. *The Lancet Infectious Diseases*, *5*(12), 751–762. doi:10.1016/S1473-3099(05)70295-4

Whitby, M., Pessoa-Silva, C. L., McLaws, M.-L., Allegranzi, B., Sax, H., Larson, E., … Pittet, D. (2007). Behavioral considerations for hand hygiene practices: The basic building blocks. *Journal of Hospital Infection*, *65*(1), 1–8. doi:10.1016/j.jhin.2006.09.026

World Health Organization. (2009a). WHO guidelines on hand hygiene in health care: First global patient safety challenge clean care is safer care. Retrieved from http://whqlibdoc.who.int/publications/2009/9789241597906_eng.pdf

World Health Organization. (2009b). A guide to the implementation of the WHO multimodal hand hygiene improvement strategy. Geneva: World Health Organization. Retrieved from http://www.who.int/gpsc/en/

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