2016

Chiropractic Student Infection Control Practices and Methicillin-Resistant Staphylococcus aureus Skin Infections

Jonathon Todd Egan
Walden University

Walden University

College of Health Sciences

This is to certify that the doctoral dissertation by

Jonathon Egan

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

Review Committee
Dr. Raymond Panas, Committee Chairperson, Public Health Faculty
Dr. Peter Anderson, Committee Member, Public Health Faculty
Dr. James Rohrer, University Reviewer, Public Health Faculty

Chief Academic Officer
Eric Riedel, Ph.D.

Walden University
2016

Abstract

Chiropractic Student Infection Control Practices and Methicillin-Resistant

Staphylococcus aureus Skin Infections

by

Jonathon Todd Egan

DC, New York Chiropractic College, 2006

MPH, ATSU School of Health Management, 2006

BS, Brigham Young University, 1998

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Health - Epidemiology

Walden University

February 2016

Abstract

Chiropractic training involves many hours of skin contact, and chiropractors have manual contact with millions of patients annually, but chiropractic has only had professional clinical hygiene guidance since 2010. Methicillin-resistant *Staphylococcus aureus* (MRSA) is the most common cause of cultured skin and soft tissue infection (SSTI) in the United States. Using the epidemiologic triad of person, place, and time as a framework, this quantitative, cross-sectional study obtained the first assessment of MRSA SSTI incidence among chiropractic students and its association with infection control behaviors (hand and table hygiene, sharing gowns, and sharing lotion) and initiation of patient care. The study obtained surveys from 312 students attending half (9/18) of U.S. chiropractic campuses. Associations were assessed by χ^2 and Fisher's exact test. Stratum specific effects were assessed. Two logistic regression models were produced. The results were that attendance at Campus 6 was associated with postmatriculation MRSA SSTI in univariate analysis, $p = 0.010$. There was an interaction between campus attended, sharing lotion, and postmatriculation MRSA SSTI, with the Mantel-Haenszel pooled estimate varying significantly from unity, χ^2 (1) = 6.75, $p = 0.009$. No other association between any assessed factor and MRSA SSTI was detected. Logistic regression models were significant ($p < 0.05$), but the composing variables were not. For social change, chiropractic colleges should instruct students and chiropractic associations could encourage members not to share massage lotions and emollients during the practice of manual therapy to help prevent MRSA SSTI.

Chiropractic Student Infection Control Practices and Methicillin-Resistant

Staphylococcus aureus Skin Infections

by

Jonathon Todd Egan

DC, New York Chiropractic College, 2006

MPH, ATSU School of Health Management, 2006

BS, Brigham Young University, 1998

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Health - Epidemiology

Walden University

February 2016

Dedication

This work is dedicated to my wife, Heidi, for the dedication and support she has always given me. I could not have done this without her. I also dedicate this to Sam, Maggie, Lily, Josie, and Ruthie, who can now have their daddy back. Ruthie, I've been doing this since before you were born–thanks, sweetheart. Sam, I thought I would have been done with this long before you left home–thank you and I'm sorry it took so long. Last, I dedicate this to my parents whose electric typewriter tapped out a lullaby night after night when my father was completing his PhD when I was a child and to Heidi's parents: "Dr. Buchert, I presume." The support of my family has meant everything to me. Thank you all.

Acknowledgments

I sincerely thank Dr. Raymond Panas, my dissertation chair, who helped me overcome many difficulties to reach this point. His guidance has been indispensable. I also gratefully acknowledge Dr. Peter Anderson, my dissertation committee member. Dr. James Rohrer served as my University Research Reviewer. Thank you to each of you. Thank you to Dayna Herrington who provided valuable review. Earlier dissertation work was with Dr. Donald Goodwin, Dr. Maria Rangel, and Dr. Chad Moretz.

My appreciation is extended to Dr. Clay McDonald who hired me as a Fellow at NYCC. Thank you to Pat Merkle for teaching me about Qualtrics. I thank Dr. Wendy Maneri, Ms. Jen Sessler, Dr. Mike Mestan, and Dr. Jean Burke for their encouragement. Thanks to everyone at the Campus Health Center, especially Ms. Theresa Ward.

A true thanks to Mike Dorr, Jay Martin, John Rutkowski, and Tony Gross who helped me pass this Bravery Test and keep looking forward when I needed it. Your gift blessed someone else's life!

Arthur Francis, Steven Free, Larry Wilson, Gennaro Fazio, Mike Lindquist, Tyson Marostica, Jim Duchine, Keith Baker, Ross Storey, Jaron Soren, LaMont Schiers, Brian DiGiovanni, and the late Milt Jones worked closely with me at church during these past 10 years. Thank you for your support. Related thanks to Charlotte Robinson, Colleen Beavers, Toni DiGiovanni, and all the ward counsel. You made the burden light.

To everyone who supported our family through our house fire–you have our eternal thanks. You made it possible for us to keep going, including with this dissertation.

Life is good and full of so many lovely people. Thank you all.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction to the Study

Introduction

Chiropractors have not historically appreciated mainstream infection control or clinical hygiene. Bartlett Joshua Palmer, who grew Palmer College of Chiropractic, the largest chiropractic college (Keating, Cleveland, & Menke, 2004; Peterson & Wiese, 1995), stated “Chiropractors have found in every disease that is supposed to be contagious, *a cause in the spine*” (as cited in Campbell, Busse, & Injeyan, 2000, para. 8). A survey of chiropractors in Alberta, Canada, found that 1 in 5 (19.7%) of 503 chiropractors agreed with the statement “most diseases are caused by spinal malalignment” (Russell, Injeyan, Verhoef, & Eliasziw, 2004, p. 374). This is concerning in an era of antibiotic-resistant disease such as methicillin-resistant *Staphylococcus aureus* (MRSA).

The perception of chiropractic treatment of the spine as essential to health promotion and disease prevention has been held historically (Wiese, 1996) and currently (Busse, Morgan, & Campbell, 2005; Campbell et al., 2000) by some chiropractors. A chiropractic editor opined during the 2009 influenza epidemic that spinal manipulation was key to prevention (McCoy, 2009). To the extent spinal manipulation rather than mainstream infection control is believed to control pathogens, clinical hygiene might be expected to suffer. Reflecting this, the American Chiropractic Association (ACA) did not provide guidance about hygiene in typical encounters until 2010 (ACA, 2010, 2011); chiropractors suggested guidance in 2009 (Evans, Ramcharan, Floyd et al., 2009).

A lack of appreciation for infection control in a profession might not be concerning if the group was small or not involved in healthcare. However, there are 44,400 chiropractic jobs (Bureau of Labor Statistics, 2014) and 70,000 licenses held in the United States (National Board of Chiropractic Examiners [NBCE], 2010). Chiropractic colleges graduate 2,500 new chiropractors per year in the United States (Bezold, Rowley, & Bettles, 2005); 9,863 students were enrolled in 2013, according to Integrated Postsecondary Education Data System (IPEDS) data (McCoy Press, 2013). Chiropractic is the largest healthcare profession outside of mainstream medicine (Meeker & Haldeman, 2002). These thousands of students and providers use a therapy based on manual skin contact (ACA, 2015; Evans, Ramcharan, Floyd, et al., 2009; Peterson & Bergmann, 2002). There is a poorly studied and possibly significant infection transmission potential among these chiropractors and students stemming from skin contact during millions of annual patient contacts (Barnes, Bloom, & Nahin, 2008; Davis, Sriovich, & Weeks, 2009; Peterson & Bergmann, 2002) and hundreds of hours of student training (NBCE, 2010; New York Chiropractic College [NYCC], 2010; Peterson & Bergmann, 2002). This profession is not small and is involved in healthcare. Chiropractic infection control beliefs and behaviors matter; in this study, I assessed this phenomenon in the MRSA era.

MRSA is the most common cause of cultured skin and soft tissue infection (SSTI) in U.S. emergency rooms (Moran et al., 2006; Talan et al., 2011) and primary care clinics (Parchman & Munoz, 2009), and the Centers for Disease Control and Prevention (CDC) states that MRSA is a key antibiotic resistant organism that threatens human health

(CDC, 2013a). Half (53.9%) of U.S. hospital *S. aureus* isolates are resistant (Mera et al., 2011), and invasive MRSA is one of the most important causes of U.S. infectious disease mortality, killing over 18,000 per year (DeLeo, Otto, Kreiswirth, & Chambers, 2010; Klevens et al., 2007). The most virulent MRSA strain–USA300-0114–often causes community outbreaks (DeLeo et al., 2010; Tenover & Goering, 2009). MRSA SSTI in nonoutbreak settings is not well understood, though infection control behaviors such as hygiene behaviors have been implicated in MRSA transmission (Bearman et al, 2010; Begier et al., 2004; CDC, 2013c; Elias, Chaussee, McDowell, & Huntington, 2010; Ellis et al., 2014; Hall, Bixler, & Haddy, 2009; Lee, N.E. et al., 2005; Maree et al., 2010; Miller, L. G. et al., 2007; Nerby et al., 2011; Romano, Lu, & Holtom, 2006; Wertheim et al., 2006).

MRSA has been studied in medical settings, and risks for MRSA in medical settings are documented (Calfee et al., 2009; CDC, 2010; Klevens et al., 2006; Klevens et al., 2007; McDougal et al., 2010; Naimi et al., 2003). However, there has not been a study of MRSA infection history and hygiene behaviors among U.S. healthcare students–including chiropractic students themselves, despite parallel MRSA environmental contamination rates in chiropractic (Bifero, Prakash, & Bergin, 2006; Burnham, Peterson, Vavrek, & Haas, 2009; Evans, Breshears, Campbell, Husbands, & Rupert, 2007; Evans et al., 2008; Puhl, Reinhart, Puhl, Sellinger, & Injeyan, 2011) and medical (Ohl et al., 2012) settings, despite chiropractic's professional lack of clinical hygiene guidance and historic disregard of mainstream infection control, and despite the community spread of MRSA (Chambers, 2001; David & Daum, 2010; DeLeo et al., 2010). This unexplored population was the focus of this research. The social significance lies in the potential to better understand and impact MRSA infection history, infection control, and hygiene compliance in the frequent skin contact profession of chiropractic, beginning in chiropractic education. Through the remainder of this chapter I provide background and highlight the gaps in knowledge related to chiropractic and MRSA SSTI addressed through this study. I state the problem statement, purpose, and variables, as well as the research questions and hypotheses. I introduce the conceptual framework, with further detail provided later in the literature review (Chapter 2). I provide operationalization of terms, assumptions, scope, and limitations. Last, I summarize social change implications.

Background

Healthcare students with significant skin contact during training have not previously been evaluated relative to personal MRSA SSTI. Given that MRSA is transmitted by skin contact (David & Daum, 2010; DeLeo et al., 2010), the existence of few studies regarding MRSA transmission among these students with frequent skin contact during training is an important gap. Both existing studies in U.S. medical and osteopathic students–which were nasal carriage studies only and not the important outcome of SSTI–were conducted with the hypothesis that MRSA exposure might be increased with training and participation in patient care (Chamberlain & Singh, 2011; Slifka, Nettleman, Dybas, & Stein, 2009). There are no prior studies of MRSA transmission or infection among massage therapy, physical therapy, or chiropractic students (all programs with significant skin contact). Study of MRSA SSTI among all U.S. healthcare students is needed to characterize infection history, associated infection control behaviors, and risk factors among those who will graduate to careers of patient contact. However, chiropractic's size and historic tension with mainstream infection control made this question particularly pertinent and an important place to start.

Problem Statement

The problem is that the incidence of MRSA SSTI in chiropractic students is unknown and their risk factors are inadequately documented–and this is in a setting where chiropractic students have frequent, regular skin contact as they train (NBCE, 2010; NYCC, 2010) in an era when MRSA is prevalent and transmits easily in the community (Chatterjee & Otto, 2013; Freitas, Harris, Blake, & Salgado, 2010; Mera et al., 2011; Tenover & Goering, 2009). In a frequent skin contact setting such as chiropractic education, MRSA SSTI history and infection control behaviors are essential to understand for transmission control among current students and in the interest of patients who will be seen after graduation (Barnes et al., 2008; Davis et al., 2009). Thus, the incidence of self-reported MRSA and associated infection control behaviors required assessment.

Purpose of the Study

This quantitative, cross-sectional study obtained the first correlation of infection control hygiene behaviors (frequency of hand and table hygiene, sharing of lotions/lubricants, and sharing of patient practice gowns) and initiation of patient care with self-reported MRSA SSTI in chiropractic students. Control variables included age, gender, race, nation of origin, healthcare exposures (surgery, hospitalization, central venous catheterization, residence in a long term care facility, dialysis, and prior MRSA

SSTI), military service, jail, intravenous drug use, and campus. The intent was to reveal the incidence of self-reported MRSA SSTI in chiropractic students as well as associated infection control and other factors, consistent with the epidemiologic triad.

Research Questions and Hypotheses

The infection control behaviors were sharing lotions/lubricants (Nerby, 2011) and gowns (Bearman et al., 2010) and frequency of hand and table hygiene (Evans & Breshears, 2007; Evans et al., 2007; Evans, Ramcharan, Ndetan et al., 2009). Control variables included age (Bearman et al., 2010); race (Hota et al., 2007; Naimi et al., 2003); the healthcare exposures of prior MRSA SSTI, hospitalization, surgery, central venous catheterization, dialysis, and residence in a long term care facility (CDC, 2010, 2013b; Klevens et al., 2006; McAllister, Gaynes, Rimland, & McGowan, 2010; McDougal et al., 2010); intravenous drug use (Lloyd-Smith et al., 2010; Miller, L. G. et al., 2007; Miller, L. G. et al., 2012; Nourbakhsh, Papafragkou, Dever, Capo, & Tan, 2010; Rafee et al. 2012); military service (Ellis et al., 2007; Ellis, Hospenthal, Dooley, Gray, & Murray, 2004; Tracy et al., 2011); having been in jail; gender; and nation of origin (Bearman et al., 2010; Gorwitz et al., 2008). *Frequent* was the *always* and *frequently* responses, and *infrequent* was all others.

RQ1. Is frequency of hand hygiene (frequent vs. infrequent) between practice partners and patients significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI?

***H_0*1.** Frequency of hand hygiene (frequent vs. infrequent) between practice partners and patients is not significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

***H_a*1.** Frequency of hand hygiene (frequent vs. infrequent) between practice partners and patients is significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

RQ2. Is frequency of treatment table hygiene (frequent vs. infrequent) between practice partners significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI?

***H_0*2.** Frequency of treatment table hygiene (frequent vs. infrequent) between practice partners is not significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

***H_a*2.** Frequency of treatment table hygiene (frequent vs. infrequent) between practice partners is significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

RQ3. Is sharing of lotions, emollients, and lubricants significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI?

***H_0*3.** Sharing lotions, emollients, and lubricants is not significantly different ($p <$ 0.05) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

***H_a*3.** Sharing lotions, emollients, and lubricants is significantly different ($p <$ 0.05) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

RQ4. Is sharing of patient practice gowns significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI?

***H_0*4.** Sharing of patient practice gowns is not significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

***H_a*4.** Sharing of patient practice gowns is significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

Some researchers have evaluated stage of education (preclinical/clinical) in U.S. healthcare programs relative to MRSA in students (Slifka et al., 2009). The theory is that patient exposure increases the possibility of MRSA exposure (Chamberlain & Singh, 2010; Slifka et al., 2009). The following question assessed this possibility.

RQ5. Is stage of chiropractic education (institution of patient care or not) significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI?

***H_0*5** Stage of chiropractic education (institution of patient care or not) is not significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

***H_a*5** Stage of chiropractic education (institution of patient care or not) is significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

The independent variables were frequency of hand hygiene in RQ1 and table hygiene in RQ2, sharing of lotions/lubricants in RQ3 and patient practice gowns in RQ4, and stage of education (initiation of patient care) in RQ5. The dependent variable was self-reported MRSA SSTI. Control variables have been described. Variables were obtained by questionnaire. Associations were assessed by χ^2. The Mantel-Haenszel summary measure of effect assessed confounding, with adjusted odds ratios reported. Effect modifiers were assessed and stratum specific estimators were reported by interaction term.

Conceptual Framework for the Study: Epidemiologic Triad

The conceptual framework grounding this study was the epidemiologic triad redescribed by Rohrer, Grover, and Moats (2013). In that example, several studies were evaluated to demonstrate how this framework guides analysis. Under this framework inquiry “[locates] variation in person, place, and time” (Rohrer et al., 2013, p. 166).

The distribution of the risks for MRSA transmission and infection are not uniform; researchers have attempted to detect and describe risk factors that those affected share (e.g., Bearman et al., 2010; Gorwitz et al., 2008; Miller, L. G. et al., 2012). These risks have person (e.g., gender or age), place (e.g., nation of origin or location of graduate study), or time (e.g., stage of study) elements. The logical connection among these key framework elements is that they are fundamental to descriptive epidemiology (Porta, 2008). When the person, place, and time risk factors that chiropractic students with SSTI have in common are determined, these factors should have biological plausibility consistent with knowledge of MRSA transmission and infection (even while filling knowledge gaps) and not strain credulity (Hill, 1965). I will discuss this further in Chapter 2.

In the present study, I assessed person, place, and time factors relative to MRSA SSTI in a previously unstudied population: chiropractic students. The research tool assessed self-reported MRSA SSTI and infection control behaviors with a questionnaire derived from Bearman et al., (2010), the CDC, (2013b), and Evans and Breshears, (2007). My analysis evaluated the association between infection control behaviors (sharing of lotions/lubricants and patient practice gowns and frequency of hand and table hygiene) and patient care exposure and MRSA SSTI in chiropractic students, controlling for age, race, nation of origin, gender, history of military service or jail, history of intravenous drug use, health care exposures (surgery, hospitalization, dialysis, central venous catheterization, residence in a long term care facility, or prior MRSA SSTI), and campus.

There is a documented lack of support for mainstream infection control procedures such as immunization and clinical hygiene practices among chiropractors (Evans, Ramcharan, Ndetan et al., 2009; Medd & Russell, 2009; Russell et al., 2004).

Some chiropractors believe spinal manipulation–a central chiropractic treatment (Peterson & Bergmann, 2002; NBCE, 2010)–prevents infection (New York Chiropractic Council, 2010). Additionally, a segment of chiropractors feel it is safer to contract a disease (Colley & Haas, 1994)–or would even prefer infection (Russell et al., 2004)–than be immunized. The ACA policy on clinical hygiene in typical chiropractic clinical encounters was introduced in this milieu in 2010 (ACA, 2010, 2011; Evans, Ramcharan, Floyd et al., 2009). Chiropractic students are likely to see other students displaying poor clinical hygiene (Evans & Breshears, 2007; Evans, Ramcharan, Ndetan et al., 2009), chiropractors are likely to obtain information from antivaccination sources (Injeyan, Russell, Verhoef, & Mutasingwa, 2006), and chiropractic associations publish pieces indicating that spinal manipulation renders recipients impervious to bacteria (New York Chiropractic Council, 2010). Nearly all chiropractic therapies use direct hand contact (Evans, Ramcharan, Floyd et al., 2009), and hand hygiene compliance in chiropractic is poor (Evans & Breshears, 2007; Evans, Ramcharan, Ndetan et al., 2009) as it often has been in all of mainstream healthcare (Boyce & Pittet, 2002). The infection control beliefs and practices documented here rendered exploration of MRSA SSTI history among chiropractic students compelling to me and elevated the need for me to employ the epidemiologic triad of person, place, and time as a lens to guide analysis among these students.

Importantly, hygiene behaviors in chiropractic educational settings can improve (Evans, Ramcharan, Ndetan et al., 2009)–and practitioners are supportive of infection control policies even when they do not have them in their offices (Puhl et al., 2011).

There are chiropractic authors countering chiropractic views that oppose mainstream infection control practices (Murphy, Schneider, Seaman, Perle, & Nelson, 2008) and reviewing MRSA literature (Green et al., 2012)–and chiropractic accrediting bodies require graduates to understand clinical hygiene (The Council on Chiropractic Education [CCE], 2012b). More recent chiropractic student surveys reveal that opinions towards mainstream infection control practices such as vaccination can evolve (Lameris, Schmidt, Gleberzon, & Ogrady, 2013), and researchers are studying how they might positively influence that process (McMurty et al., 2015). These facts provided optimism that study findings could produce social change and--in concert with the need to address the outlined knowledge gaps--compelled the study.

In Chapter 2, I will further explore this literature. The epidemiologic triad provided a conceptual framework to analyze risk in terms of person, place, and time; discoveries made in this study could permit social change through targeted improvements in hygiene behaviors to interrupt MRSA transmission in this population and enhance understanding of potentially modifiable risks, per identified need (Lowy, 2013).

Nature of the Study

The study design was cross-sectional. The cross-section permitted me to calculate MRSA SSTI incidence and association with hygiene behaviors and generate further hypotheses–without determination of causality (Porta, 2008). This study was quantitative to facilitate my assessment of SSTI incidence and any associated infection control behaviors.

I solicited a census of all students (rather than a random sample) from a sampling frame consisting of all matriculated and current chiropractic students at all U.S. chiropractic colleges that approved the study–9 of the 18 U.S. chiropractic college campuses participated. The study was powered (as described in Chapter 3) to answer the research questions if 370 students responded; 312 students ultimately responded. I provided each an electronic, IRB-approved informed consent form and questionnaire (Appendix A). I kept identifiable information confidential and secure.

I obtained self-reported MRSA SSTI incidence (the dependent variable) via the questionnaire (Bearman et al., 2010; CDC, 2013b; Evans & Breshears, 2007), as well as the independent variables (initiation of patient care, sharing of gowns, sharing of lotions, frequency of hand hygiene, and frequency of table hygiene) and control variables (college location, age, gender, race, nation of origin, history of intravenous drug use, healthcare exposures, jail, and military service). I determined the association between the variables using the questionnaire data per methods described here and in Chapter 3.

I assessed confounding and effect modification relative to the control variables. I compared characteristics of participants to understand if participants and nonparticipants differed. This study was the first of its kind among chiropractic students and findings from this study may justify active surveillance, comparison studies with students of other health professions, or international comparative studies.

Definitions

Healthcare Exposures

The CDC has defined six healthcare risk factors (HRFs) to distinguish healthcare-associated (HA)-MRSA epidemiologically. In my study HRFs were assessed by questionnaire as *healthcare exposures* and were closely adapted from the CDC's Invasive Methicillin-Resistant–*Staphylococcus aureus* Active Bacterial Core Surveillance (ABCs) Case Report--2013 (CDC, 2013b). The six HRFs are as follows: prior MRSA infection, and any of the following in the prior 12 months: hospitalization, surgery, dialysis, central vascular catheter, and residence in a long-term care facility (CDC, 2010, 2013b; Klevens et al., 2006; McDougal et al., 2010). These served as control variables in this study. Prior MRSA infection was limited to prior MRSA SSTI. I assessed the other healthcare exposures as having occurred in the 12 months prior to reported MRSA SSTI or in the 12 months prior to the study for those who had not had MRSA SSTI.

MRSA SSTI

It is possible that students may have suffered SSTI that was MRSA but was not cultured. They would not know they had MRSA SSTI. I only counted self-reported, diagnosed MRSA SSTI in the present study. SSTI is infection of the skin tissues, including boils, cellulitis, folliculitis, abscess, impetigo, erysipelas, and similar infections, with or without purulence (Stevens, D. L. et al., 2014). MRSA SSTI with invasive infection counted, but invasive infection alone did not. Participants were instructed that their answers regarded only the presence of diagnosed MRSA SSTI.

Assumptions

The main assumption in this study was that MRSA SSTI in a chiropractic student population occurred at sufficient rates to detect relationships if present. This assumption was believed but could not be determined until the study's conclusion. This assumption was important as there were no data on the incidence or prevalence of MRSA SSTI in the general population (CDC, 2013c), let alone in a chiropractic population. MRSA SSTI incidence data are available for similarly aged athletes and military trainees (Creech et al., 2010; Ellis et al., 2007; Ellis et al., 2014). My study involved chiropractic students, a special population with frequent, regular skin contact during training and practices that may be inconsistent with mainstream infection control.

Scope and Delimitations

My decision to assess self-reported history of MRSA SSTI was to cast as wide a net as possible, maximizing study representativeness. To attempt to assess 370 chiropractic students from at least three U.S. chiropractic college campuses, I needed a survey methodology–ultimately reaching 312 participants at nine campuses. Surveys should reduce selection bias by not having an onerous participation method, but the method relied on the willingness of chiropractic colleges to participate. The ability to reach students impacts study representativeness and external validity. As these survey and invitation emails were sent by the colleges to their own students via addresses assigned by the chiropractic colleges and via the colleges' communication method with their own students, all students at participating colleges had the potential to be reached, whether or not they chose to respond. The data were directly imported for analysis to minimize the possibility of data entry error.

In this study, I did not use prospective surveillance to detect MRSA SSTI. Nor did I use retrospective chart reviews to detect diagnosed MRSA SSTIs that students were not informed of or had forgotten. The survey method I used relied on participant recall, introducing the potential for recall bias and potentially affecting internal validity. However, the questions I posed were largely framed as yes/no/unsure questions and many covered a 12-month timeframe, helping to minimize this bias (Bradburn, Sudman, & Wansink, 2004). Participants often find yes/no questions (did a behavior occur?) easier to interpret than frequency questions (how often did a behavior occur?)–and these questions facilitate response when asked in series and are aided by reference to a shorter timeframe (such as less than 12 months; Blair, Sudman, Bradburn, & Stocking, 1977; Brener, Billy, & Grady, 2003; Tourangeau & Smith, 1998). In this study, I often relied on these methods to reduce these biases, enhancing internal validity.

I relied on self-reported MRSA SSTI because of the survey methodology. This introduced possible classification bias--some individuals may have had MRSA SSTI and not known it because they were not cultured. This impacts external validity when compared to studies that classify MRSA by genotype or phenotype. Control of this bias was aided by how I posed the question to this educated population; for example: "Did you ever have a medically diagnosed MRSA infection of the skin or of the tissues under the skin *after* starting to attend chiropractic college?" This clarified the specific infections of interest. Through the question's introduction, I pointed out that MRSA, "mersa," and “antibiotic resistant staph” were the concern for further clarification. In absence of MRSA SSTI incidence data in the general population, I felt that even a conservative estimate of MRSA SSTI in a large, novel, frequent skin-contact population known to have nonstandard infection control views and millions of patient contacts was worth effort and study to obtain.

Regarding construct validity of the questionnaire, there was no standard MRSA SSTI questionnaire for community-based infections in nonoutbreak settings (Macario, Daum, Eells, & Miller, 2010). Investigators developed outbreak questionnaires for investigations, but these did not apply here (Kazakova et al., 2005; Nguyen, Mascola, & Bancroft, 2005). A questionnaire used to classify MRSA was referenced (CDC, 2013b). Researchers have developed a variety of questionnaires to explore MRSA risk factors in community populations (Bearman et al., 2010; Miller, L. G. et al., 2007). As there was no established questionnaire for the purposes (Macario et al., 2010), construct validity for the study questionnaire stemmed from my basing the questionnaire in preexisting questionnaires (Bearman et al., 2010; CDC, 2013b; Evans & Breshears, 2007).

For this study, I was concerned with self-reported MRSA SSTI, not environmental contamination with MRSA on environmental surfaces such as tables, stethoscopes, privacy curtains, and other similar items. Other studies in chiropractic educational settings have explored environmental contamination, (Bifero et al., 2006; Burnham et al., 2009; Evans et al., 2007; Evans et al., 2008). As a delimitation, I did not include overt assessment of contamination or table exposure.

Last, I designed this study to assess infection control behaviors among chiropractic students attending at least 3 of 15 accredited U.S. chiropractic institutions (CCE, 2012a)–and ultimately had participation of 9 of the 18 campuses (some colleges have multiple campuses). Some colleges did not permit the study, which impacts external validity. However, I compared participating student demographics to publicly available demographics of U.S. chiropractic students in Chapter 4 to generally assess study participant representativeness. My study results apply to the sampling frame of all students at participating U.S. chiropractic colleges but do not apply outside the United States or to other health professions students. However, the results of this study may provide a rationale to perform a larger study using prospective surveillance among chiropractic students, or of specific chiropractic campuses, and could inform studies among other health professions or countries.

Limitations

There are four main limitations of design and methodology. The first is that I used recall as the collection method, introducing potential recall bias (Porta, 2008). Had I used active prospective surveillance of all SSTIs with polymerase chain reaction (PCR) or medical records review the assessment would have been more sensitive and minimized this bias but with much greater resource intensity (Wolk, Marx, Dominguez, Driscoll, & Schifman, 2009). I did not use prospective surveillance due to resource limitations–but as the first foray into this novel population and to establish the need for future analytic study, survey-based recall was an acceptable research tool (Merrill, 2013). Control of recall bias was discussed in Scope and Delimitations.

Second, I relied on diagnosis of MRSA SSTI for this study. It is possible that students have experienced SSTIs that were MRSA and did not know it. This may have introduced misclassification bias, as discussed in Scope and Delimitations.

Third, I relied on emailed surveys rather than personal contact. Better-resourced studies–such as NHANES (Gorwitz et al., 2008)–have contacted potential participants individually by phone. I sought responses from 370 students attending half of U.S. chiropractic college campuses by inviting responses from every student at nine participating campuses. While online questionnaires can be nonthreatening and are well received (Crutzen & Göritz, 2011), selection bias (Creswell, 2009)–specifically consent bias (Porta, 2008)–is introduced if respondents differ from nonrespondents. To help assess and control this bias, I compared characteristics of participants to all students to monitor for differences between participants and nonparticipants (Miller, M. et al., 2009; Uhlemann et al., 2011).

Fourth, I did not verify responses for veracity. If participants were not truthful, response bias may have been introduced (Creswell, 2009; Porta, 2008). One study on nose-picking and MRSA used a physician to validate responses through nasal inspection (Wertheim et al., 2006). This is unusual–practical and ethical concerns often limit validation of self-reported data (Brener et al., 2003). However, questionnaires offer data that would otherwise be difficult to obtain, and questionnaires of even sensitive information are able to obtain valid data, even if not independently verified (Brener et al., 2003; Zimmerman & Langer, 1995), particularly if confidentiality is assured (Aquilino, Supple, & Wright, 1998; Crutzen & Göritz, 2011; Macario et al., 2010; Tourangeau &

Smith, 1998). Online survey responses were confidential and the survey system is secure (Qualtrics QLite version). Students were informed that no data category with less than five responses would be reported individually.

Significance

Chiropractic students have frequent hand-to-skin contact while training and will collectively have millions of postgraduate patient contacts. Chiropractors have not historically embraced mainstream infection control behaviors. This is concerning in the MRSA era. However, the incidence of self-reported MRSA SSTI and associated risk factors among chiropractic students was previously unknown. I designed this study to help fill this gap and provoke meaningful social change, knowing that understanding and addressing modifiable infection control behaviors and other risk factors could potentially reduce SSTI incidence in this frequent skin contact setting and perhaps impact transmission after graduation. Relationships discovered could be used to inform future prospective studies among chiropractic students, other college students, or students of other health professions.

Summary

Chiropractic students are a group at risk for MRSA SSTI secondary to infection control practices and evidenced in hygiene guidance provided only in 2010 (ACA, 2010, 2011). The incidence of MRSA SSTI in this group was not known, and associated infection control behaviors required elucidation. Information acquired through this study began to fill these gaps.

In this chapter, I discussed the problem statement, purpose, hypotheses, and conceptual framework of this study. I detailed the logical connection between variables and described the nature of the study. I reviewed the assumptions, limitations, and implications of the study. In Chapter 2, I further review evidence regarding variables, concepts, and methods, and I confirm the positive social change potential of this research.

Chapter 2: Literature Review

Introduction

Chiropractic students share close contact for hundreds of hours as they practice their manual skills (NYCC, 2010; Peterson & Bergmann, 2002) in settings with MRSA exposure (Evans, Ramcharan, Floyd et al., 2009). MRSA is the leading cause of cultured SSTI in emergency rooms and in primary care in the United States (Moran et al., 2006; Parchman & Munoz, 2009; Talan et al., 2011). Chiropractic students may have characteristics that would permit MRSA amplification consistent with observations in other settings (Aiello, Lowy, Wright, & Larson, 2006; Miller, L. G. & Diep, 2008).

The epidemiologic triad holds that risk factors are not randomly distributed and that infection is not random; risk can be located in terms of person, place, and time (Rohrer et al., 2013). Health students have unique characteristics; in Chapter 1, I noted that health students in the United States require further study relative to MRSA transmission as does community transmission in general. Chiropractic students particularly merited study, as they may believe and act in ways that preclude consistent adoption of mainstream infection control practices, perhaps predisposing to amplified transmission and infection. These students will eventually interact with millions of patients (Barnes et al., 2008; Davis et al., 2009). This may represent a potential risk to patients but has been inadequately assessed. The ACA adopted a clinical hygiene policy for typical chiropractic clinical encounters only in 2010, remarkably late given that chiropractic is largely a manual therapy and healthcare providers' hands carry pathogens (ACA 2010, 2011; Creamer et al., 2010; Evans, Ramcharan, Floyd et al., 2009).

However, it was not known to what extent chiropractic students experience MRSA SSTI. The prevalence of some MRSA risk factors and infection control hygiene practices in this population was unknown, as was their association with MRSA SSTI.

While MRSA SSTI incidence among chiropractic students required study, SSTI incidence and risk factors have been studied in cross-section, retrospectively, and prospectively in limited community studies; the overall incidence in the United States is unknown (CDC, 2013c). For example, in a retrospective study of 195,255 hospital admission surveillance cultures of individuals 18 years old or older in a 4-hospital health system, the annual risk of having a MRSA positive clinical culture was 0.6% or 8.0%, depending on baseline PCR-determined MRSA nasal carriage ($p < 0.0001$; Ridgway et al., 2013). A prospective study of college athletes found a 1-year incidence of MRSA SSTI of 0.79% in 126 athletes (Creech et al., 2010). Several prospective studies of MRSA SSTI among military trainees have been conducted (Ellis et al., 2007; Ellis et al., 2009; Ellis et al., 2014; Ellis et al., 2004) and I will discuss these in this chapter.

I addressed at least two gaps with this cross-sectional study. First, this study addressed the unquantified incidence of self-reported diagnoses of MRSA SSTI in chiropractic students, a population that historically has not appreciated mainstream infection control behaviors. Second, I sought to elucidate infection control and other risk factors associated with self-reported diagnoses of MRSA SSTI in this nonoutbreak community population.

MRSA is a key antibiotic resistant organism (CDC, 2013a). Implications for social change are better understanding of MRSA SSTI incidence in the largest healthcare profession outside of mainstream medicine (Meeker & Haldeman, 2002, p. 216). Improved understanding of modifiable risks (in person, place, and time context) in this high-contact, high-patient volume healthcare profession should be of broader interest.

In this chapter, I review the literature search strategy and conceptual foundation of the present study. Key variables and concepts are reviewed, justified, and evaluated. Pertinent studies are synthesized and major themes are summarized. I conclude this chapter with an evaluation of what is and is not known in this field and a description of how this study addressed the gap and extended knowledge of MRSA epidemiology.

Literature Search Strategy

In this section, I discuss databases and search terms used, as well as the search scope. I provide findings in table form, and I review key articles in Literature Review Related to Key Variables and/or Concepts. I conducted literature searches regarding MRSA, particularly community-associated (CA)-MRSA within the United States, and chiropractic. I evaluated seminal and current peer-reviewed literature and I reviewed important references from bibliographies. The reviewed literature informed my study design and methodology and I discuss the literature in this chapter and Chapter 3.

Databases, Search Terms, and Summary Findings

I searched two databases for literature related to MRSA and chiropractic: the Index to Chiropractic Literature (ICL) and PubMed. The ICL is a specialty database maintained by the Chiropractic Library Collaboration and contains links to articles published by chiropractic publishers (Chiropractic Library Collaboration, 2012a). I searched the ICL by index terms. I searched PubMed using medical subject heading

(MeSH) terms, a controlled vocabulary used to index and search for biomedical articles in the National Library of Medicine (National Library of Medicine, 2011). I conducted both searches with *English language* as a filter, as the review covers MRSA particularly within the United States and as the study regards U.S. chiropractic students.

ICL and chiropractic/MRSA literature. I searched the ICL from the first year of indexing using the index term *methicillin-resistant* Staphylococcus aureus and when no primary literature was found, I searched the ICL more broadly for chiropractic infection control literature with pertinent index terms (Chiropractic Library Collaboration, 2012b): *infection control*, *infection*, *staphylococcal infections*, *staphylococcal skin infections*, *hygiene/standards*, *hygiene*, *hand washing*, *clinical protocols*, and *immunization* (the latter being a very broad increase in the search, reflecting my desire to capture chiropractic infection control attitudes and behaviors when so little other literature was revealed). I also used one nonindexed term (*MRSA*). Excluding commentaries, college course content surveys, case reports, historical reviews, letters to the editor, and other nonprimary research, my search yielded 10 articles on infection control attitudes and practices (half were related to immunization), no primary MRSA research, and one included hygiene protocol (see Table 1).

Table 1

Chiropractic Infection Control Primary Literature from ICL and PubMed

Database	Search terms[a]	Primary research articles
Index to Chiropractic Literature (ICL)	Methicillin-resistant *Staphylococcus aureus,* MRSA[b], Staphylococcal infections, Staphylococcal skin infections, clinical protocols	None
	Infection control	Burnham et al. (2009); Evans et al. (2007); Evans et al. (2008); Evans, Ramcharan, Floyd et al. (2009)[c]; Evans, Ramcharan, Ndetan et al. (2009)
	Hygiene / standards	Evans & Breshears, (2007); Evans et al. (2007)
	Hygiene	Evans & Breshears, (2007); Evans et al. (2007)
	Hand washing	Evans, Ramcharan, Ndetan et al. (2009)
	Immunization	Colley & Haas, (1994); Injeyan et al. (2006); Medd & Russell, (2009); Page, Russell, Verhoef, & Injeyan, (2006); Smith & Davis, (2011)
PubMed	Chiropractic and methicillin resistance; Chiropractic and soft tissue infections; Chiropractic and skin diseases, infectious	None
	Chiropractic and methicillin-resistant *Staphylococcus aureus*	Burnham et al. (2009)
	Chiropractic and hygiene	Evans, Ramcharan, Ndetan et al. (2009)
	Chiropractic and (vaccination or immunization)	Busse, Kulkarni, Campbell, Injeyan, (2002); Busse, Wilson, & Campbell, (2008); Colley & Haas, (1994); Hawk, Long, Perillo, & Boulanger, (2004); Injeyan et al. (2006); Medd & Russell, (2009); Page et al. (2006); Russell et al. (2004); Schmidt & Ernst, (2003)

Note. ICL = Index to Chiropractic Literature; MRSA = methicillin-resistant *Staphylococcus aureus*; MeSH = medical subject heading. [a]For ICL, search terms are index search terms and for PubMed, search terms are MeSH terms. [b]*MRSA* was not an ICL-indexed search term, but was searched in an open term search, when the index term produced no results. [c]This reference is the sole nonprimary research source in this table: a proposed protocol for chiropractic clinical hygiene.

Literature could be indexed incorrectly, leaving literature undiscovered through the use of index terms. The paucity of literature discovered, the failure of the nonindex term *MRSA* to locate literature in ICL, the dearth of literature discovered in the PubMed search (noted next), and the review of article reference sections for chiropractic/MRSA primary research literature (and even chiropractic/infection control primary research), all increase confidence that the applicable literature is sparse and was located.

PubMed and chiropractic/MRSA literature. I searched PubMed from the first year of its indexing using the MeSH terms *methicillin-resistant* Staphylococcus aureus to find articles from 2009 to the present, and the term *methicillin-resistance* to locate articles from 1982 to 2008 (as MRSA indexing changed in 2009; National Library of Medicine, 2012). I produced 6,955 articles with this search. The stark contrast of zero primary research articles indexed by the term *methicillin-resistant* Staphylococcus aureus in the ICL and nearly 7,000 articles indexed with these terms in the medical literature revealed a significant gap in the chiropractic literature. I searched the database of nearly 7,000 PubMed articles for two main categories of information: (a) MRSA literature directly related to chiropractic and (b) general MRSA background literature.

Chiropractic/MRSA literature. I performed searches using the MeSH terms *chiropractic* and *methicillin resistance* and *chiropractic* and *methicillin-resistant* Staphylococcus aureus to search for MRSA literature directly related to chiropractic. The first search produced no primary research, and the latter search produced one primary article that was already found in the ICL. To broaden the search, I used the MeSH terms *chiropractic* and *soft tissue infections* and *chiropractic* and *skin diseases, infectious* without producing any primary research. I then broadened the search even further (see Table 1). In Table 2, I summarize the literature discovered by these searches in both databases, as well as through the review of reference sections of located references.

Table 2

Chiropractic Primary Infection Control Literature–Consolidated

Type	Sources
Primary research literature from PubMed and ICL Search	Burnham et al. (2009); Busse et al. (2002); Busse et al. (2008); Colley & Haas, (1994); Evans & Breshears, (2007); Evans et al. (2007); Evans et al. (2008); Evans, Ramcharan, Ndetan et al. (2009); Hawk et al. (2004); Injeyan et al. (2006); Medd & Russell, (2009); Page et al. (2006); Russell et al. (2004); Schmidt & Ernst, (2003); Smith & Davis, (2012)
Primary research literature from review of reference sections	Bifero et al. (2006); Davis, Smith, & Weeks, (2012); Downee, Tyree, Huebner, & Lafferty, (2010); Jones, Sciamanna, & Lehman, (2010); Pokras & Iler, (1990); Russell, Verhoef, & Injeyan, (2005); Stokley, Cullen, Kennedy, & Bardenheier, (2008)
Infection control protocol	Evans, Ramcharan, Floyd et al. (2009)[a]
Historical reviews[b]	Anderson (1990); Busse et al. (2005); Campbell et al. (2000); Wiese, (1994)
Case report of infection acquired in chiropractic clinic[c]	Istre et al. (1982)

Note. ICL = Index to Chiropractic Literature.
[a]This protocol (not primary research) was recommended by the American Chiropractic Association as a suggested resource to US chiropractors, and I include it here on those terms. This article references an earlier Australian guideline that is not included here. [b]Historical reviews and perspectives are not considered primary research literature here, and receive only passing mention. These references represent a selection, generally of chiropractor-authored reviews. Anderson (1990) is an early review of chiropractic attitudes towards immunization from a medical sociology journal. Busse et al. (2005) and Campbell, J.B. et al. (2000) are chiropractor-authored reviews about chiropractic and immunization. Wiese (1994) is a chiropractor-authored historical review of chiropractic and the germ theory from a chiropractic history journal discovered through a review of reference sections. [c]This reference was located through a review of reference sections, and is included as an item of historical interest (though not primary research). It is the only documented case of infection transmission within a chiropractic practice in the literature.

While I found 28 articles that regarded any aspect of infection control in chiropractic, none concerned MRSA SSTI or risk factors for assessed SSTI. This was again evidence of a significant gap. Over half the articles regarded immunization, and I provide a summary of chiropractic literature relative to that mainstream infection control practice in Appendix B. Several articles in Tables 1 and 2 concerned MRSA and other pathogens on chiropractic treatment surfaces, though none were related to MRSA SSTI or risk factors. I summarize all English language primary literature regarding MRSA and pathogens on chiropractic treatment surfaces in Table 3.

Table 3

Chiropractic Treatment Table Contamination, Focusing on MRSA

Source	Setting and sample method	Examined	Results
Pokras & Iler, (1990)[a]	Academic chiropractic clinics–tables selected by unknown method	Unknown number of tables in 58 patient encounters; in the first 29 encounters, the face paper was assessed before and after treatment, while in the second 29 encounters, a 20x40cm area on the table face piece was assessed 1) after disinfecting the table before treatment and 2) after treating the patient while using a paper barrier to cover the face piece	Both after disinfection and after treatment with a paper barrier, the table face pieces contained minimal bacterial load–essentially 1 cultured bacterial colony per table; after treatment, the face paper produced 39 cultured bacterial colonies each (compared to less than 1 colony before treatment) and 17% of colonies were *S. aureus*[b]
Bifero et al. (2006)	Academic chiropractic clinic open to the public–tables randomly selected by lottery	9 treatment tables, 4x4in area on each of 4 surfaces per table (armrests, face piece, thorax piece)–samples taken at the end of the day without alerting student interns	2/9 tables (22%) contained MRSA; potentially infectious pathogens isolated from 7/9 (78%) tables
Evans et al. (2007)	Academic chiropractic clinic open to the public–tables selected by convenience	10 treatment tables, 6cmx6cm area on face piece, entire arm pieces–time of sample acquisition not indicated	1/10 tables (10%) contained MRSA; disinfection per standard protocol eliminated MRSA on retest
Evans et al. (2008)	Academic chiropractic clinic–all cloth tables were selected in a single clinic chosen by convenience	14 cloth-covered treatment surfaces, cultures taken of both halves of the face piece with a culture plate directly pressed against the face piece–time of sample acquisition not indicated	0/14 cloth tables/benches (0%) contained MRSA; potentially infectious pathogens were isolated from the tables (a photograph of the cultures was provided, showing growth on all cultures, but a count or details of what percentage of tables were affected were not given)
Burnham et al. (2009)	Multiple sites: academic chiropractic clinic for students, academic chiropractic clinic open to the public, academic chiropractic clinic located within the community open to the public, and academic labs for students to practice/learn–all clinic tables and a random selection of lab tables were selected	45 treatment tables (all of the tables) at the academic chiropractic clinics and 6/24 randomly selected tables from the practice labs, 4x4 inch square encompassing the face piece only (the smallest sampling area of all of these studies)–samples taken at baseline, 4 months, 8 months, and 12 months, always at the start of the day on the same day of the week per site	4/45 tables (9%) in academic clinics contained MRSA at baseline, 0/6 tables in practice labs contained MRSA at baseline; after a disinfection protocol intervention, in 3 other combined sampling frames, 3/135 tables (2% of [45 tables x 3 sampling frames]) contained MRSA in academic clinics, 0/18 tables (0% of [6 tables x 3 sampling frames]) contained MRSA in practice labs
Puhl et al. (2011)	Private chiropractic clinics[c]–the most frequently used table by clinician report was assessed	14 treatment tables (the most frequently used table in each of 14 clinics), 3 3x5 inch areas (a hand rest, the caudal-most portion of the face piece, and a portion immediately adjacent on the face piece)–samples taken between 12 and 6 PM	3/14 tables (21%) contained MRSA, isolated from both sections of the face piece and the arm rest; 14/14 tables (100%) contained coagulase negative staphylococci and *micrococcus luteus*; 5/14 (36%) contained *S. aureus*

Note. MRSA = methicillin resistant *Staphylococcus aureus*. This table contains all English-language primary literature examining for pathogens on chiropractic treatment tables, listed chronologically. All assessed for MRSA except Pokras and Iler (1990), who assessed for *S. aureus*.

[a]Pokras & Iler (1990) and Puhl et al. (2011) performed bacterial counts. No other researchers did. [b]The face paper was an effective barrier to bacterial transfer from the patient's face to the table face piece to the extent that it prevented face contact with the face piece. Puhl et al. (2011) explicitly noted that there are areas on face pieces that the face paper does not cover that patients' faces will contact, and they examined this phenomenon in their study. [c]These clinics were in Alberta, Canada, while all of the other studies were performed in the United States, and these clinics were private, while all other clinics were associated with chiropractic colleges.

General MRSA literature. After finding little research on chiropractic and MRSA, and no literature on MRSA SSTI in these students, I conducted a background search in PubMed for MRSA literature that could reflect on the present study. I note this literature here in three groups: studies of nonoutbreak MRSA SSTI in college students and college-aged adults, risk factors for nonoutbreak MRSA SSTI in noninstitutionalized community members, and prospective studies of nasal carriage and subsequent infection (a risk factor for SSTI with multiple studies).

No studies of MRSA SSTI in nonoutbreak settings among general college students in the United States have been performed; there have been a few outbreak investigations among college athletes (Begier et al., 2004; Nguyen et al., 2005; Romano et al., 2006) and one retrospective chart review of infections in seven student athletes at one university (Cohen, 2005b) and one case report of a single student by the same author (Cohen, 2005a). One prospective study of MRSA SSTI among college athletes also has been conducted (Creech et al., 2010) and I will review this later in Literature Review Related to Key Variables and/or Concepts. Most studies regarding MRSA in college students regard MRSA nasal carriage--not the focus of my study (see Appendices C and D). This represents the paucity of MRSA SSTI data among college students, despite the fact that MRSA SSTI incidence in the community has increased 84.7% between the period spanning 1997 and 2002 and the period spanning 2003 to 2008 based on ICD-9 coding (Meddles-Torres, Hu, & Jurgens, 2013). I conducted the search using combinations of the MRSA search terms and *student, intern, resident, medical, nursing, physical therapy, massage therapy, college, athlete, prevalence, incidence,* and *nasal* *carriage*, excluding articles on hospital infection, or articles from college students outside the United States (a table of carriage rates in health professions students outside the United States is in Appendix E) as MRSA strains and virulence vary globally, and searching reference sections of located references to find additional sources. I review one article related to MRSA nasal carriage in college students in Literature Review Related to Key Variables and/or Concepts (Bearman et al., 2010), as it had a significant number of risk factors studied in a (largely) college student population and questions from the survey instrument in that study were used in my study.

I located several large, prospective, non-outbreak studies of MRSA SSTI in military trainees, which provided some of the most useful MRSA SSTI data outside of hospital settings. These studies are Ellis et al. (2004), Ellis et al. (2007), and Ellis et al. (2014). Though military trainees are a unique population, they are college-aged adults. Though some of these studies had intervention arms or placebos, they still have important natural history information and I review them in Literature Review Related to Key Variables and/or Concepts. Annual SSTI rates as high as 8.1% were found (Ellis et al., 2004).

Expanding scope of the review to include any non-institutionalized adults over age 18 in non-outbreak settings, I located a retrospective study of 195,255 hospital admission surveillance cultures in a 4-hospital health system that found that the annual risk of having a MRSA positive clinical culture was 0.6% or 8.0%, depending on baseline PCR-determined MRSA nasal carriage ($p<.0001$; Ridgway et al., 2013). This study is not perfectly applicable my study as these MRSA clinical cultures not only included MRSA

SSTI but also included blood, sputum, and urine cultures. However, the study was quite large, and gives some sense of MRSA SSTI incidence in the absence of general data (CDC, 2013c).

Many studies have assessed risk factors for MRSA infection, but many of these have been conducted in hospital settings. For this study I located articles using combinations of the MRSA search terms and *epidemiology*, *risk* and *risk factors,* excluding articles exclusively regarding HA-MRSA, nosocomial infection, or hospital care in general (to reveal any community-associated risk factors); and searched reference sections of located references to find additional sources. As I discovered risk factors I then searched the database for them specifically in combination with the other search terms. I located many articles, and germane articles were included that reported the risk factor to be associated with SSTI in non-outbreak settings. I note risk factors for MRSA SSTI in noninstitutionalized adults identified in at least 1 study (preferably in multivariable analysis) in Table 4. I also review key articles from this search in the Literature Review Related to Key Variables and/or Concepts. MRSA nasal carriage is a risk factor for Community-Associated (CA)-MRSA SSTI; I list nasal carriage in Table 4 as a risk factor for MRSA SSTI, but refer from there to Table 5 (which exclusively regards prospective assessment of nasal carriage and MRSA SSTI because of the volume of associated literature). I separately note the risk factors for MRSA nasal carriage in college-aged students in Appendix D.

Table 4

Risk Factors for MRSA SSTI in Noninstitutionalized Adults in Nonoutbreak Settings

Risk factor	Source	Population	Study design	Findings
Age	Hota et al. (2007)	518 patients with MRSA and 704 with MSSA at a 464-bed Chicago hospital and over 100 clinics associated with the hospital; patients were at least 1 year of age (mean age with MRSA culture: 35.4 years); MRSA infection cultures from soft tissue, abscess, bone or joint fluid.	Prospective, observational cohort	In multivariate analysis, older age per decade inversely associated with CA-MRSA SSTI; *OR* 0.89, 95% *CI* [0.82, 0.96], *p* = 0.004
	Miller, L. G. et al. (2007)	180 adult patients with MRSA and 72 with MSSA at Harbor-UCLA Medical Center (mean age with MRSA culture: 41.4 years) MRSA infection; infection cultures from wound, blood, urine, or sputum.	Prospective, observational cohort	Older age per decade inversely associated with CA-MRSA SSTI; *OR* 0.96, 95% *CI* [0.94, 0.99], *p* = 0.009; age was the only variable still associated in multivariable analysis
	Naimi et al. (2003)	1,100 patients with MRSA cultures and 3,512 patients with MSSA cultures at 12 labs in Minnesota; mean age with MRSA culture: 23 years; MRSA infection cultures from SSTI (75%), the ear (7%), respiratory tract (6%), blood (4%), urinary tract (1%), and other (8%)	Prospective, observational cohort	CA-MRSA median age (23 years) vs. HA-MRSA age (68 years) significantly different, *p* < 0.001
Antimicrobial usage	Como-Sabetti, Harriman, Fridkin, Jawahir, & Lynfield (2011)	75 patients with MRSA, 75 patients with MSSA, 226 MRSA controls, and 212 MSSA controls in Minnesota; mean age with MRSA culture: 24 years; MRSA infection cultures from SSTI, blood, joint, bone, urine, eye, or sputum. Antimicrobials were counted only if prescribed, but excluded if within 30 days of culture, as could have been for index infection.	Prospective, case-control (case-case CA-MRSA and CA-MSSA, and case-control for each)	Antimicrobial usage in the prior 6 months associated with MRSA infection compared to MSSA infection (*OR* 2.2, *p* = 0.05) and compared to controls (*OR* 2.9, *p* < 0.01)
Frequent attendance at bars, raves, and clubs[a]	Miller, L. G. et al. (2007)	Described above	Described above	Attendance associated with MRSA SSTI; MSSA vs. MRSA *OR* 0.64, 95% *CI* [0.40, 1.0], *p* = 0.03
Hand-laundering clothing in hot water	Miller, L. G. et al. (2007)	Described above	Described above	Hand laundering associated with MRSA SSTI; MSSA vs. MRSA OR 0.76, 95% *CI* [0.56, 1.0], *p* = 0.05
History of skin infection or SSTI	Como-Sabetti et al. (2011)	Described above	Described above	History of skin problems associated with MRSA infection compared to MRSA controls (*OR* 1.1, *p* = 0.01); history of boils associated with MRSA infection compared to MSSA infection (*OR* 8.7, *p* = 0.04) and MRSA controls (*OR* 13.2, *p* < 0.01)

(*table continues*)

Risk factor	Source	Population	Study design	Findings
History of skin infection or SSTI (continued)	Ridgway et al. (2013)	195,255 adults admitted in a 4 hospital Northshore University Health System and receiving nasal MRSA carriage surveillance tests; followed for one year; clinical cultures within the year were 45% SSTI and included 12% invasive (not the focus of the present study), as well as urine, sputum, and other.	Retrospective observational	14.3% of patients with past MRSA positive culture plus positive baseline culture have MRSA positive clinical culture again within year, while 8.0% of those with current positive culture and no prior history have MRSA positive clinical culture again within year, $p < 0.001$
Household smokers	Como-Sabetti et al. (2011)	Described above	Described above	History of smoking associated with MRSA infection compared to MSSA infection (*OR* 2.0, $p < 0.01$) and MRSA controls (*OR* 2.0, $p < 0.01$)
Illegal drug use (inhaled or intravenous)	Miller, L. G. et al. (2007)	Described above	Described above	Inhaling illicit drugs associated with MRSA SSTI; MRSA vs. MSSA *OR* 2.9, 95% *CI* [1.2, 6.8], $p = 0.01$
	Nourbakhsh et al. (2010)	102 patients undergoing hand irrigation and debridement for intraoperative cultured infection, 32 with MRSA mean age of all patients: 39 years	Retrospective chart review	In the multivariate model, only intravenous drug use associated with CA-MRSA SSTI, $p = 0.023$
	Szumowski et al. (2010)	Described above	Described above	In the final multivariate model restricted to culture confirmed MRSA SSTI, crystal methamphetamine use was associated with MRSA SSTI (data not shown)
Incarceration	Hota et al. (2007)	Described above	Described above	In multivariate analysis, incarceration within 1 year associated with CA-MRSA SSTI; *OR* 1.92, 95% *CI* [1.00, 3.67], $p = 0.05$
	Miller, L. G. et al. (2007)	Described above	Described above	Incarceration within 1 year associated with MRSA SSTI; MRSA vs. MSSA *OR* 2.8, 95% *CI* [1.1, 7.3], $p = 0.03$
Lower Charlson comorbidity index score	Miller, L. G. et al. (2007)	Described above	Described above	Charlson comorbidity score inversely associated with MRSA SSTI; *OR* 0.76, 95% *CI* [0.61, 0.94], $p = 0.01$
MRSA colonized household members	Stevens, A. M. et al. (2010)	316 participants from an earlier case-control study in rural Alaska; average age not reported, median age for skin infection of any kind during study period: 17 years	Retrospective cohort	MRSA colonized household member associated with MRSA SSTI in non-colonized case within 1 year, *RR* 1.4, 95% *CI* [1.0, 2.1], $p = 0.007$
MRSA nasal colonization	See Table 5			

(*table continues*)

Risk factor	Source	Population	Study design	Findings
Perianal MRSA carriage	Szumowski et al. (2010)	Described above	Described above	In the final multivariate model restricted to culture confirmed MRSA SSTI, perianal MRSA colonization associated with MRSA SSTI (data not shown)
Race/ethnicity	Hota et al. (2007)	Described above	Described above	In multivariate analysis, African American race/ethnicity associated with CA-MRSA SSTI; *OR* 1.91, 95% *CI* [1.28, 2.87], p = 0.002
	Naimi et al. (2003)	Described above	Described above	CA-MRSA race vs. HA-MRSA: race more likely non-white, *OR* 3.13, 95% *CI* [2.16, 4.32]
	Ray, Suaya, & Baxter (2013)	376,262 patients with 471,550 SSTIs in a retrospective records review of all emergency department, hospital, and clinic visits over 3 years in an over 3 million member integrated healthcare delivery system in Northern California	Retrospective, observational	In multivariable analysis, African American race/ethnicity compared to white race/ethnicity associated with CA-MRSA SSTI, *OR* 1.79, 95% *CI* [1.67, 1.92] and Hispanic race/ethnicity compared to White race/ethnicity, *OR* 1.24, 95% *CI* [1.18, 1.31]; Asian race/ethnicity protective compared to White race/ethnicity, *OR* 0.73, 95% *CI* [0.68, 0.78]
Residence in some public housing	Hota et al. (2007)	Described above	Described above	In multivariate analysis, public housing in one geographic area associated with CA-MRSA SSTI; *OR* 2.50, 95% *CI* [1.25, 4.98], p = 0.009

Note. MRSA = methicillin resistant *Staphylococcus aureus;* SSTI = skin and soft tissue infection; CA-MRSA = community associated MRSA; HA-MRSA = healthcare associated MRSA; MSSA = methicillin sensitive *Staphylococcus aureus*; *CI* = confidence interval; *OR* = odds ratio; *RR* = relative risk. This table considers cultures within the first 72 hours of hospital admission as community infection; Como-Sabetti et al. (2011) and Naimi et al. (2003) only include 48 hours. Most studies include a small proportion of pediatric patients (Como-Sabetti et al., 2011; Hota et al., 2007; Nourbakhsh et al., 2010; Stevens, A. M. et al., 2010). Ray et al. (2013) included about 23% pediatric patients and Naimi et al (2003) included about 40% pediatric patients.
[a]Specifically bars, raves, and clubs frequently attended by men who have sex with men

Table 5

CA-MRSA Nasal Colonization and Subsequent Infection, Prospectively Assessed

Source	Population	Study design	Findings
Creech et al. (2010)	126 college athletes (female lacrosse players and male football players)	Prospective, observational	One year surveillance of 126 male and female student athletes; 37% of male athletes had at least one positive nasal culture in 8 sampling frames and as many as 23% of female athletes were simultaneously nasally colonized over 6 sampling frames; of 5 SSTI developed over the year, 1 was culture confirmed as MRSA (and the athlete was not simultaneously nasally colonized with MRSA); no relationship between CA-MRSA nasal carriage and SSTI was detected
Ellis et al. (2004)	812 US Army soldiers in specialty training immediately after basic training	Prospective, observational	24 MRSA colonized soldiers at baseline, of whom 9 (38%) developed infection (predominantly SSTI) within 8-10 weeks; 229 MSSA colonized soldiers at baseline, of whom 8 (3%) developed infection within 8-10 weeks, *RR* 10.7, 95% 95% *CI* [4.6, 25.2], $p < 0.001$
Ellis et al. (2007)	3447 US Army soldiers in specialty training immediately after basic training	Prospective, cluster randomized, placebo-controlled trial	131 MRSA colonized soldiers at baseline followed for 16 weeks, half of whom were randomized to receive mupirocin to decolonize, the other half received placebo decolonization; 5/65 (7.7%, 95% *CI* [4.0%, 11.4%]) and 7/66 (10.6%, 95% *CI* [7.9%, 13.3%]) of those MRSA colonized soldiers receiving mupirocin and placebo decolonization developed infection within 16 weeks (i.e., mupirocin did not perform better than placebo at preventing SSTI in nasally colonized soldiers)
Fritz, Epplin, Garbutt, & Storch, (2009)	708 children and household members from a previous prospective study of 1300 community children	Retrospective follow up of participants originally prospectively enrolled	26 MRSA colonized children at baseline, of whom 6 (23%) developed SSTI within 6 months; 194 MSSA colonized children at baseline, 16 (8%) of whom developed SSTI within 6 months, *OR* compared to all other participants including non-colonized with *S. aureus*, 3.3, 95% *CI* [0.9, 12.0], $p = 0.014$. 22 MRSA colonized children at baseline, of whom 7 (31.8%) developed SSTI within 12 months; 142 MSSA colonized children at baseline, 14 (9.9%) of whom developed SSTI within 12 months, *OR* compared to all other participants including non-colonized with *S. aureus,* 6.4, 95% *CI* [3.4, 12.2]
Garza et al. (2009)	108 players and staff of the San Francisco 49ers	Prospective, observational	No players were nasally colonized with MRSA at the start of the season, yet 5 players developed MRSA infection through the course of the season (and were not colonized nasally at the time of infection)
Szumowski et al. (2009)	795 patients at an ambulatory care clinic serving a large population of men who have sex with men (547/795 or 69% of participants) and patients with HIV (243/795 or 31% or participants)	Prospective observational	26 MRSA nares-colonized patients as baseline, of whom an unreported number developed SSTI, though it was reported that a nares positive culture was strongly associated with later infection, *OR* 4.81, 95% *CI* [1.73, 12.13], but did not retain significance in multivariate analysis in this population, while perianal colonization did

Note. *CI* = confidence interval; *OR* = odds ratio; *RR* = relative risk; MRSA = methicillin resistant *Staphylococcus aureus;* CA-MRSA = community associated MRSA; MSSA = methicillin sensitive *Staphylococcus aureus*; SSTI = skin and soft tissue infection.
[a]This article did not have a baseline MRSA colonization assessment and therefore does not technically parallel the other articles in this table, but is included here because it is the largest prospective assessment of MRSA SSTI

CA-MRSA nasal carriage has been evaluated prospectively in several studies, as well as through many retrospective investigations. I located these articles using combinations of the MRSA search terms and the terms *nasal carriage*, *nares*, *anterior nares*, *epidemiology*, *incidence, prevalence,* and *prospective;* excluding articles exclusively regarding HA-MRSA, nosocomial infection, or hospital care in general, and searching reference sections of located references to find additional sources. I provide prospective CA-MRSA nasal carriage and SSTI literature in Table 5.

Two important retrospective studies of MRSA SSTI bear mention. Ridgway et al. (2013) and Ray et al. (2013) performed large-scale assessment of CA-MRSA SSTI. Ridgway et al. (2013) studied nasal surveillance assessments in 195,255 admissions in a 4-hospital system and all associated clinics. The one-year risk for MRSA clinical culture or MRSA SSTI after a baseline nasal assessment was as low as 0.6% for those with negative PCR surveillance at baseline, or 2.8% for those with positive PCR surveillance but negative confirmatory culture at baseline, or as high as 6.4% for those with positive PCR plus positive confirmatory culture at baseline and excellent study follow-up. These authors reveal prior MRSA infection to be a key risk for future positive MRSA clinical cultures–though this study did not just explore MRSA SSTI.

Ray et al. (2013) assessed 471,550 SSTI episodes in a population-based assessment from 2009 to 2011 in an integrated healthcare system representing over 3 million members. The rate of clinical diagnosis of SSTI was 496 per 10,000 person years; as 37% of cultured SSTI was MRSA, the rate of clinical diagnosis of MRSA SSTI in this population that exceeded 3 million persons was 1.8 per 100 persons per year, or

1.8% per year. The authors excluded hospital-based infections through a variety of inclusion and exclusion criteria, leaving a rate that is a good estimate of a population-based community incidence of MRSA SSTI.

One last prospective study that would have been included in Table 5, but did not include carriage assessment, is noted here because of the scale of the study and the assessment of MRSA SSTI incidence. Ellis et al. (2014) assessed 26,251 U.S. Army soldiers in specialty training in a prospective, field-based, cluster-randomized trial. Soldiers were cluster randomized to 3 different SSTI education and prevention groups in their 14-week training. The education-only group included 8,155 trainees; 86 (1.1%) developed MRSA SSTI. The enhanced hygiene group included 9,250 trainees; 135 (1.5%) developed MRSA SSTI. The chlorhexidine bath group included 8,846 trainees; 95 (1.1%) developed MRSA SSTI. There was no significant difference in MRSA SSTI rates among the three groups per 100 14-week person cycles. This rate, when consolidated and converted to an annual rate of MRSA SSTI (rather than a 14-week rate), is 4.09%.

Together these studies reveal annual rates of MRSA infection (largely SSTI) in non-institutionalized, non-outbreak settings ranging from 0.6% in adults (Ridgway et al., 2013) to 1.8% (Ray et al., 2013) in all ages, with higher rates in some groups such as 6.4% or higher in adults with positive PCR test and positive nasal culture (Ridgway et al., 2013). Annualized rates in military trainees were as high as 8.1% (Ellis et al., 2004) and I will further elucidate this as key background data in the section on CA-MRSA epidemiology and will use these data in power calculations in Chapter 3.

Literature Search Strategy: Summary

Through the literature search I found that while thousands of articles pertaining to MRSA have been published, including several evaluating SSTI outbreaks in college settings, there is little information on the incidence of MRSA SSTI in college students or college-aged adults. Further, there is no study of MRSA SSTI in students of the health professions in the United States, including medicine, osteopathy, chiropractic, physical therapy, or massage therapy. There is little prospective literature regarding MRSA SSTI in community populations, and the prevalence of MRSA SSTI in the non-institutionalized U.S. adult population is unknown (CDC, 2013c). Through the literature review process I located many nasal carriage studies, most of which were cross-sectional--I provide many of these in Appendices C, D and E. Few articles addressed any facet of MRSA and chiropractic, despite the fact that chiropractic is a frequent skin contact profession. Given that CA-MRSA is rapidly spreading in the community and is a leading and expanding cause of SSTI, an important gap in the literature is evident.

Conceptual Framework: Epidemiologic Triad

The conceptual framework I used to support this study is the epidemiologic triad of person, time, and place. Epidemiology concerns the distribution of the determinants of health, which are not random; this distribution has person, time, and place characteristics (Merrill, 2013; Porta, 2008; Rohrer et al., 2013). This conceptual framework holds that (in this case) chiropractic students with MRSA SSTI must share common elements–such as inadequately deployed infection control behaviors–that predispose to infection that are not shared at the same frequency by those without SSTI, and these factors should be able to be ascertained (Merrill, 2013). The factors should be biologically plausible and not strain credulity (Hill, 1965). Person, place, and time factors are central to descriptive epidemiology (Merrill, 2013; Porta, 2008).

The first person to describe disease as having non-random, predictable characteristics was Hippocrates. The term *epidemic*–meaning *upon the people*–was also first used by Hippocrates, and is the root of the term *epidemiology* (Merrill, 2013; Porta, 2008). Hippocrates discussed how disease affected different populations differently under different conditions and in different seasons: person, place, and time factors (Hippocrates, 400 BCE). Hippocrates stated that each disease has its own characteristics and none is suffered without "natural cause" (400 BCE, Part 22, para. 1).

Other early thinkers and practitioners who also approached disease with the perspective that those afflicted must share common characteristics (now termed person, place, and time) included Sydenham in the 1600s who studied fevers, Lind in the 1700s who identified the cause and treatment of scurvy, Jenner in the 1700s who built upon the work of others to develop vaccination against small pox, Semmelweis in the 1800s who discovered the cause of childbirth fever and advocated for clinical hygiene, and John Snow in the 1800s who is considered the Father of Epidemiology (Merrill, 2013).

John Snow studied cholera in London. Two significant events from his career establish the utility of closely studying person, place, and time factors: the Broad Street pump episode and the Lambeth/Southwark and Vauxhall Water Company episode. In the former, about 500 cholera deaths happened in a very short time near Broad Street. Snow immediately suspected the Broad Street pump–the water supply for the neighborhood–

because of his background study of the disease. He directly observed the water quality of the pump and noted that it fluctuated greatly from day to day. He hypothesized the water must have been unusually poor at the time of the start of the outbreak. Snow plotted the deaths on a map and noted that there were two protected areas: a brewery and a workhouse, both of which had their own wells. He also noted the role of the Broad Street pump, finding that almost all of the deaths happened in households within a very short distance of the pump. “I had an interview with the Board of Guardians ... and represented the above circumstances to them. In consequence of what I said, the handle of the pump was removed the following day” (Snow, 1855, p. 40). Person, place, and time factors were closely implicated in cholera deaths.

The other episode regarded a large outbreak of cholera in London. This episode was eventually determined to result from consumption of water from the Southwark and Vauxhall water company. The Southwark and Vauxhall company drew water from the sewage polluted Thames, in contrast to the Lambeth water company that drew water upstream from the sewers. This amounted to a natural experiment, as some communities largely had water from one source, others communities from the other source, and some communities from both.

> The experiment, too, was on the grandest scale. No fewer than three hundred thousand people of both sexes, of every age and occupation, and of every rank and station, from gentlefolks to the very poor, were divided into two groups without their choice, and, in most cases, without their knowledge; one group being supplied with water containing the sewage of London, and, amongst it,

> whatever might have come from the cholera patients, the other group having water quite free from such impurity.
>
> To turn this grand experiment to account, all that was required was to learn the supply of water to each individual house where a fatal attack of cholera might occur. (Snow, 1855, p. 75)

Snow was successful in this determination. The rates of cholera were different in communities with different water sources (with cholera associated with Southwark and Vauxhall water)–but in the community with blended sources, Snow used techniques to assess the specific water company used by households smitten with cholera. Southwark and Vauxhall overwhelmingly supplied these smitten households. Snow discovered 286 cholera deaths among users of Southwark and Vauxhall water (40,046 houses), but only 14 deaths from consumption of Lambeth water (26,107 houses). The proportion of fatal attacks was 71 per 10,000 households for Southwark and Vauxhall but only 5 per 10,000 for Lambeth (Snow, 1855)–a difference of a factor of 14. Again, Snow demonstrated that cholera fatalities were linked to person, place, and time factors.

The provided examples indicate the importance of understanding the non-random, natural causes (Hippocrates, 400 BCE) that compose the person, time, and place factors that create risk for disease or other health outcomes: the epidemiologic triad. Person factors "include age, gender, race/ethnicity, marital and family status, occupation, and education" (Merrill, 2013, p. 120). Person factors can also include behaviors, beliefs, and other personal characteristics that can be assessed about individuals. Rohrer et al. (2013) described that person factors could include what physicians felt influenced their prescribing practices. In the present study, person factors assessed as independent variables were sharing of lotions and patient gowns and frequency of hand and table hygiene. Person factor control variables included gender, race, age, healthcare exposures, military service, jail, and history of intravenous drug use.

Place factors relate to where phenomena occur or what geographical elements impact the distribution of health outcomes (Merrill, 2013; Porta, 2008). Rohrer et al. (2013) described variation in antibiotic prescribing practice by clinic location. In the present study, the location factor control variables were the nation of origin (United States or other) and chiropractic college campus, with 9 of 18 U.S. campuses participating.

Time refers to the temporality of distribution that could be impacted by exposure, incubation, latency, or other temporal factors (Merrill, 2013). Rohrer et al. (2013) evaluated prescribing practice by day of the week. In the present study, the time factor was the stage of education (clinical/preclinical–i.e., initiation of patient care or not).

Tables 4 and 5 demonstrate how this framework has been applied in similar studies. In those studies, participants with MRSA infection had questionnaire, patient chart, or demographic assessment to assess for person, place, and time risk factors that were significantly different from those without SSTI. Assessed person characteristics included race, gender, and a variety of characteristics noted in Table 4, as well as MRSA nasal carriage noted in table 5. Assessed place characteristics included location of residence as noted in Table 4. Assessed time characteristics included whether it was the on- or off-season in sports, per Table 5.

The epidemiologic triad has been generally applied in these prior studies in the desire of these researchers to determine which factors were associated with infection (see Table 4 and 5). The triad was explicitly applied in the Rohrer et al. (2013) study, which was a case example and review of prior studies under the lens of this triad. Rohrer et al. (2013) analyzed person (employee status, patient age, and patient gender), place (clinic site), and time (day of week) factors to assess quality variation in prescribing practice using secondary data of a convenience sample of adults with acute respiratory tract infection. Time ($p = 0.0344$) and clinic ($p = 0.0001$) seemed related to antibiotic prescription in univariate analysis. However, time was an artifact of the concentration of prescriptions in one clinic–ultimately, clinic alone was associated with prescription ($OR = 0.47$, 95% *CI* [0.30, 0.73]; $p = 0.0008$). These authors reviewed 3 other studies using this triad and emphasized that all 3 factors (person, place, and time) need to be contemplated from the conception of the study and integrated into study design.

While this study (Rohrer et al., 2013) was conducted from a quality control perspective, the emphasis on the need to include person, place, and time factors in the design of epidemiologic studies is in line with the tradition extending back to John Snow. My study benefits from this epidemiologic triad framework. I designed my study to specifically include the elements of the epidemiologic triad as independent and control variables. These variables are person (frequency of hand and table hygiene, sharing of lotion and patient practice gowns, gender, age, race, military service, jail, history of intravenous drug use, and healthcare exposures), place (nation of origin and chiropractic college campus), and time (stage of education: preclinical/clinical) characteristics.

Literature Review Related to Key Variables and/or Concepts

In this literature review I review infection control in chiropractic and CA-MRSA SSTI epidemiology. I also cover studies related to the constructs and methods used in the present study; provide an evaluation of strengths and weaknesses of prior approaches; generate a review, synthesis, and justification of the chosen variables from the literature; and provide a review and synthesis of studies related to the research questions.

Chiropractic Infection Control Attitudes and Behaviors: A Brief Review

Chiropractic students merited assessment for MRSA SSTI for reasons articulated in Chapters 1 and 2 and consistent with literature outlined in Tables 1 and 2. Chiropractors in the United States have not adopted mandatory practice standards for infection control in typical clinical encounters (Evans, Ramcharan, Floyd et al., 2009). The ACA's policy is a recommendation (ACA, 2010, 2011). Infection control was not taken seriously in medicine until Oliver Wendell Holmes described its importance in 1843 and Ignatz Semmelweis conclusively established its importance in 1847--both in response to deaths from puerperal fever (Fleming, 1966). Patient care guidelines now address hand, environmental, and treatment surface hygiene (Boyce & Pittet, 2002; CDC, 2011). In dentistry, bloodborne pathogens affected clinical hygiene guidelines and compliance, beginning with documented transmission of bloodborne pathogens to dental patients (including the case of Kimberly Bergalis, who contracted HIV in a dental practice and died), followed by public pressure to change dental hygiene (Lawyer, 1994).

Infectious disease has only been documented to have transmitted in one chiropractic clinic and this transmission was related to a highly atypical treatment

(NBCE, 2010): colonic irrigation (Istre et al., 1982). In that case an improperly cleaned device led to an outbreak of amoebiasis, reflecting poor infection control in chiropractic. Infectious disease transmission in chiropractic settings has not been studied outside of this case report (Evans, Ramcharan, Floyd et al., 2009). The lack of study is consistent with the historical poor appreciation of infection control in chiropractic and late clinical hygiene guidance from the ACA (2010, 2011). Poor professional awareness and infection control practice, frequent skin contact therapy, and recently enhanced virulence of MRSA (O'Hara et al., 2008; Tenover & Goering; 2009) together produce a scenario in which amplification of MRSA transmission might be expected. I assessed this with this study.

Chiropractic student clinical hygiene. Poor infection control behaviors and beliefs/attitudes have been documented among chiropractic students. For example, 79.3% of 481 chiropractic students in their second through eighth trimesters at one college reported "never" or "rarely" disinfecting the treatment table between patients and 54.1% of students reported "never" or "rarely" noticing other chiropractic students washing their hands between patients (Evans & Breshears, 2007). The questions regarding hand and table hygiene in my study came from this questionnaire; this questionnaire was also used in the study by Evans, Ramcharan, Ndetan et al. (2009). In that study at three chiropractic colleges 27% of 765 chiropractic students reported in a preeducation survey that they felt hand hygiene was "not important," 22% felt their current practice was "poor," and 71% infrequently or "rarely" sanitized the treatment table–though self-reports did improve somewhat after a hygiene education intervention (Evans, Ramcharan, Ndetan et al., 2009). A study of chiropractors found that this extended into practice; most chiropractors did not have a clinical hygiene policy in place in their offices (Puhl et al., 2011). These behaviors had never been studied in chiropractic in association with any health outcome such as SSTI before my study.

MRSA has been detected in chiropractic environments. Of six studies evaluating pathogens on chiropractic treatment tables in educational and clinical settings, MRSA was detected in four of the five studies that looked for it, and infectious pathogens were detected in all six studies (see Table 3). Health behaviors (clinical hygiene) must therefore be inadequate consistent with student reports (Evans, Ramcharan, Ndetan et al., 2009), as simple disinfection procedures control pathogenic microbes including MRSA in chiropractic settings (Evans et al., 2007). Infection control in chiropractic is important, because not only do MRSA carriers almost certainly visit or work in chiropractic offices (Evans, Ramcharan, Floyd et al., 2009; Gorwitz et al., 2008), but patients with MRSA infection present to these offices (Larkin-Thier et al., 2010). The health beliefs and practices of chiropractic students relative to transmissible infectious organisms made them an important population to study.

Chiropractic is not unique in imperfect hygiene compliance. A review of observational studies of healthcare workers in a national guideline found that average adherence to hand hygiene guidelines was 40%, with no study demonstrating greater than 81% adherence (and some as little as 5% compliance) (Boyce & Pittet, 2002). Compliance with hand hygiene recommendations has been found to be poor in medical settings even in care of patients known to have MRSA infection or colonization (Scheithauer et al., 2010). Nonetheless, poor infection control practices among chiropractic students may also be influenced by a belief that spinal manipulation, a key chiropractic practice (NBCE, 2010), plays an important role in infection control (Campbell et al., 2000).

Chiropractic health beliefs about spinal manipulation and infection. As already noted, Bartlett Joshua Palmer, a historic chiropractic figure and leader of the largest chiropractic college (Keating et al., 2004; Peterson & Wiese, 1995), stated, "Chiropractors have found in every disease that is supposed to be contagious, *a cause in the spine*" (as cited in Campbell et al., 2000, para. 8). More recently 44.3% of 503 chiropractor respondents agreed that there was a spinal cause (*subluxation* in chiropractic parlance) to many diseases and 19.7% agreed that "most diseases are caused by spinal malalignment" (Russell et al., 2004, p. 374). Both historically and presently, many chiropractors have believed that spinal manipulation–a key chiropractic therapy–offers essential health enhancement and protection (Busse et al., 2005; Campbell et al., 2000; Wiese, 1996). This was believed true by some chiropractors about small pox (Campbell et al., 2000), influenza (McCoy, 2009), and infectious pathogens in general (Drexler, 1978, as cited in New York Chiropractic Council, 2010).

Though many chiropractors feel that spinal manipulation prevents infectious disease, spinal manipulation is not commonly considered part of any infection control strategy. No evidence to support a role for chiropractic care in treatment of any infectious disease was found in a systematic review (Hawk, Khorsan, Lisi, Ferrance, & Evans, 2007). Indeed, spinal manipulation would not be regarded as standard infection control among other chiropractors (Campbell et al., 2000; Evans, Ramcharan, Floyd et al., 2009;

Murphy et al., 2008). While there is internal chiropractic professional debate, a substantial proportion of chiropractors still believe that most disease has spinal origin (Campbell et al., 2000; Russell et al, 2004). Consistent with the health beliefs model (Schiavo, 2007) a lack of standard infection control compliance could be expected where such health beliefs pervade. MRSA amplification would be expected secondary to these behaviors. It therefore seemed important to investigate MRSA SSTI and infection control compliance among chiropractic students.

Suspected MRSA amplification. Evans, Ramcharan, Floyd et al. (2009) noted that the chiropractic profession is a skin contact profession where pathogens have been detected on patient contact surfaces, but no research has been conducted among the students or practitioners themselves. A core chiropractic textbook displays the frequent hand and skin contact between chiropractor and patient (Peterson & Bergmann, 2002). Hand hygiene and environmental hygiene are recognized as critical elements of infection control–including control of resistant organisms (Boyce & Pittet, 2002; CDC, 2011; D'Agata, Horn, Ruan, Webb, & Wares, 2012; Jain et al., 2011). Chiropractic students may be at increased risk of MRSA transmission because of the nature of their training and the documented failure to use appropriate hand or table hygiene for infection control.

These students may therefore serve as an amplifying reservoir of CA-MRSA as they live in close proximity to one another as roommates, practice manual skills with one another as students, and use poor clinical hygiene between practice partners and with practice equipment. Incubation and amplification have been described in other close settings such as prisons and prison communities (CDC, 2003b; Malcolm, 2011), military training settings (Ellis et al., 2004; LaMar, Carr, Zinderman, & McDonald, 2003; Zinderman et al., 2004), and in other college students. While chiropractic college is neither prison nor military training, chiropractic students are in close contact with one another in a relatively closed community as are those two groups (Aiello et al., 2006). The close contact chiropractic students have in their program may amplify transmission and infection opportunity. It was important to assess if this was the case, given the context of health beliefs and behaviors that may impact infection control compliance.

Chiropractic infection control attitudes and behaviors: Summary. Health beliefs related to infection control among chiropractors and chiropractic students may contribute to potentially amplified MRSA transmission and SSTI. Some chiropractors may attribute infection control properties to spinal manipulation, a core chiropractic practice. To the extent that this belief impacts behaviors, utilization of well-established infection control practices might be limited, and MRSA amplification might be expected. MRSA SSTI could be amplified in chiropractic educational settings, but this had not been previously studied. I addressed that gap with this study.

CA-MRSA SSTI Epidemiology: A Brief Review

MRSA developed in hospitals in response to antibiotic pressure (Jevons, 1961; Chambers, 2001). In hospitals, nasal carriage of MRSA was related to nosocomial MRSA infection (Huang & Platt, 2003; Klevens et al., 2006; McDougal et al., 2010; Wertheim et al., 2004). Older age, comorbidities, indwelling devices, and hospital admission were related to infection (Klevens et al., 2006; McDougal et al., 2010; Naimi et al., 2003; Salgado, Farr, & Calfee, 2003). Different strains of MRSA appeared in the community in the 1990's and early 2000's that affected the young and individuals without identifiable risk factors (Baggett et al., 2004; CDC, 1999b; Herold et al., 1998; Lindenmayer, Schoenfeld, O'Grady, & Carney, 1998; Vandenesch et al., 2003). These strains were referred to as CA-MRSA (Chambers, 2001; Daum et al., 2002; Herold et al., 1998; Saravolatz, Pohlod, & Arking, 1982).

The epidemiology of CA-MRSA appeared to undergo a shift in the early 2000's with the appearance of USA300-0114, which was particularly virulent (Kazakova et al., 2005; O'Hara et al., 2008; Tenover et al., 2006). Rapid increases in CA-MRSA prevalence were detected by a variety of measures (including active surveillance), representing true expansion and not simply increasing awareness or efforts at detection (Crum et al., 2006; Frei, Makos, Daniels, & Oramasianwu, 2010; Freitas et al., 2010; Gorwitz et al., 2008; Mera et al., 2011). Between 2002 and the latter part of the decade CA-MRSA became the most common community cause of cultured SSTI (Moran et al., 2006; Parchman & Munoz, 2009; Talan et al., 2011), with CA-MRSA SSTI a rapidly increasing cause of pediatric hospitalization (Frei et al., 2010) and with USA300 dominant (Crum et al., 2006; King et al., 2006; Tenover et al., 2006; Tenover & Goering, 2009). MRSA SSTI incidence in the community increased 84.7% between the years 1997 and 2002 and the years 2003 and 2008 based on ICD-9 coding (Meddles-Torres et al., 2013). There is a relationship between CA-MRSA nasal carriage and SSTI (Ellis et al., 2004) as noted in Table 5, though understanding of the nature of this relationship is developing (DeLeo et al., 2010; Miller, L. G., & Diep, 2008; Miller, L. G. et al., 2012).

CA-MRSA environmental contamination is also important (Uhlemann et al., 2011); Table 3 shows environmental MRSA contamination in chiropractic environments.

CA-MRSA SSTI: Incidence/prevalence. The general incidence of non-invasive MRSA SSTI is unknown (CDC, 2013c). MRSA is the most common cause of cultured SSTI in U.S. emergency rooms (Moran et al., 2006; Talan et al., 2011) and private practices (Parchman & Munoz, 2009), and the incidence of diagnosed MRSA SSTI per ICD-9 coding increased 84% from the period of 1997 to 2002 to the period of 2003 to 2008 (Meddles-Torres et al., 2013). Ray et al. (2013) evaluated 471,550 SSTI episodes in a population-based assessment from 2009 to 2011 in a health system representing over 3 million members. The rate of clinical diagnosis of SSTI was 496 per 10,000 person years; as 37% of cultured SSTI was MRSA, the rate of clinical diagnosis of MRSA SSTI was 1.8% per year.

A few incidence rates from prospective studies of college-aged individuals are available, taken from prospective studies of student athletes and military trainees. Creech et al. (2010) followed 126 college athletes through the year–five students developed skin infections (two infections were self-draining lesions, two were cultured non-MRSA, and one was MRSA). The incidence of MRSA SSTI in 126 students was 0.79%. This rate is similar to the seasonal rate reported among high school athletes (Buss & Connolly, 2014).

Three studies among military trainees have produced prospective MRSA SSTI incidence information. Ellis et al. (2004) found 11 individuals (out of 812 U.S. Army trainees) suffered diagnosed MRSA SSTI (and 18 others to have uncultured SSTI) over 8 to 10 weeks of training. This represents a rate of diagnosed MRSA SSTI of 1.4% over that time period (or an annualized rate of approximately 8.1%) in these trainees–and also demonstrates that only 37.9% of the infections were cultured, drawing attention to the likelihood of people experiencing undiagnosed MRSA SSTI. My study will focus on diagnosed MRSA SSTI. Ellis et al. (2007) screened trainees for CA-MRSA carriage at baseline and randomized trainees to placebo or mupirocin decolonization treatment for any existing or later revealed MRSA nasal colonization. In the placebo group (n=1,459) 63 (4.3%) trainees developed infection over 16 weeks–of which 24 (38.1%) were cultured and 20 (83.3%) were MRSA SSTI–an incidence of 1.4% over 16 weeks or an annualized rate of 4.56%. In the mupirocin group (n=1,607) 56 trainees developed infection over 16 weeks–of which 25 (44.6%) were cultured and 19 (76.0%) were MRSA SSTI–an incidence of 1.2% over 16 weeks or an annualized rate of 3.90%. Combined, 39 MRSA SSTIs were found over 16 weeks in 3,066 trainees, a rate of 1.3% over 16 weeks or an annualized rate of 4.2%. Ellis et al. (2014) followed 30,209 trainees over 16 weeks; trainees were cluster randomized into three groups: hygiene instruction and SSTI prevention, an enhanced group with an extra shower and training/support, and a chlorhexidine group that had a once a week preventive bath. There was no statistically significant difference in SSTI rate between groups. The combined rate of MRSA SSTI was 1.1% over 14 weeks (an annualized rate of 4.1%).

CA-MRSA SSTI: Affected population. Outbreaks and elevated risk of MRSA SSTI have been described in athletes (Begier et al., 2004; Hall et al., 2009; Kazakova et al., 2005; Romano et al., 2006), prisoners (Aiello et al., 2006; Maree et al., 2010), men who have sex with men (Diep et al., 2008), military trainees and personnel (Ellis et al., 2007; Ellis et al., 2014; Ellis et al., 2004; Zinderman et al., 2004), veterans (Tracy et al., 2011), and intravenous drug users (Lloyd-Smith et al., 2010). Healthcare exposures are a risk for SSTI (CDC, 2010, 2013b; Klevens et al., 2006; McAllister et al., 2010; McDougal et al., 2010). Prior MRSA SSTI is often considered a healthcare risk factor and also a risk factor for future SSTI (CDC, 2013b; Stenstrom et al., 2009; Stevens, D. L. et al., 2014). Healthcare exposures were control variables in the present study. MRSA nasal carriage is also an important risk factor as described in Table 5.

Risk factors that have been associated with MRSA SSTI in the community were outlined in Table 4. Despite this research there still is no standard risk factor questionnaire for CA-MRSA (Macario et al., 2010), reflecting a need to further understand and quantify MRSA SSTI risk in the community. One risk factor that has been somewhat consistent is younger age. The likelihood of CA-MRSA infection–vs. infection with non-resistant *S. aureus* strains–slightly decreased with each increasing decade of age (*OR* 0.96, 95% *CI* [0.94, 0.99] in Miller, L.G. et al., [2007], and *OR* 0.89, 95% *CI* [0.82, 0.96] in Hota et al., [2007]). CA-MRSA infection is more common in younger populations, and age was a control variable in my study.

Prior MRSA infection also appears to be a risk factor for future MRSA infection. A study of adult hospital admissions in a 4-hospital system evaluated 195,255 admissions over about four and a half years and found that MRSA infection was associated with future clinical cultures within the year (Ridgway et al., 2013). Prior MRSA SSTI was a control variable in the present study. Other risk factors described in Table 4 that were also control variables in my study include intravenous drug use, incarceration, and race. One control variable similar to a risk factor in Table 4 was chiropractic college campus; in Table 4 one study revealed a geographic cluster of MRSA SSTI (Hota et al., 2007).

CA-MRSA SSTI: Methods of control. The present study was not about MRSA control but rather MRSA SSTI incidence. In this section, I discuss the difficulties of both population and individual control of this key antibiotic resistant organism (CDC, 2013a). Treatment of MRSA nasal carriage in households has been discussed as a means to reduce MRSA transmission (Uhlemann et al., 2011; Alam et al., 2015). Alam et al. (2015) note that households may serve as reservoirs for as long as 8 years. However it is unclear what measures would address MRSA nasal carriage in the general population (Ammerlaan, Kluytmans, Wertheim, Nouwen, & Bonten, 2009; David & Daum, 2010; Skov et al., 2012); universal nasal carriage screening and elimination is not likely to be useful (Skov et al., 2012) and may only provoke unintended consequences, including antimicrobial resistance (Ammerlaan et al., 2009; Cadilla, David, Daum, & Boyle-Vavra, 2011) or new ecological space for other pathogens (Regev-Yochay et al., 2004). Targeted topical nasal mupirocin may temporarily eradicate colonization but it and SSTI frequently return (Ammerlaan et al., 2009; Coates, Bax, & Coates, 2009; Miller, L. G. & Diep, 2008). Use of nasal mupirocin to treat baseline colonization had no impact on subsequent SSTI compared to placebo in soldiers (Ellis et al., 2007). Use of chlorhexidine body wash (more expansive than nasal decolonization) did not make a difference relative to SSTI in soldiers in training (Ellis et al., 2014).

Hand hygiene is important in community (Skov et al., 2012) and healthcare settings (Jain et al., 2011), but is not a complete solution as it does not eliminate MRSA from healthcare workers' hands (Creamer et al., 2010) and cannot explain all of the MRSA reductions seen in healthcare settings (Gurieva, Bootsma, & Bonten, 2012). Clinical hygiene is needed (CDC, 2011; Skov et al., 2012) and has proven effective in reducing environmental contamination (Evans et al., 2007; Oller, Province, & Curless, 2010). Screening, treatment, and hygiene each play a role; self-reported MRSA SSTI incidence and hygiene factors were assessed in my study.

CA-MRSA SSTI: Identification. The Infectious Diseases Society of America described the diagnosis and management of SSTI in the MRSA era (Stevens, D. L. et al., 2014). Culturing and Gram staining are recommended for moderate and severe purulent SSTIs including furuncles, carbuncles, and abscesses. Abscesses are "usually painful, tender, and fluctuant red nodules, often surrounded by a pustule and encircled by a rim of erythematous swelling" (p. 13). Furuncles are hair follicle infections that extend into subcutaneous tissue–a deeper lesion than folliculitis. Carbuncles are a coalescing of furuncles. MRSA should be considered when there has been penetrating trauma including intravenous drug use, recent antibiotic use/failure, nasal carriage of MRSA, or other MRSA infection. Culturing of blood and other specimens may be warranted under some circumstances (Stevens, D. L. et al., 2014). Cellulitis is not typically of MRSA origin (Stevens, D. L. et al., 2014) though MRSA origin should be considered if abscesses are also present (Khawcharoenporn, Tice, Grandinetti, & Chow, 2010).

CA-MRSA SSTI and chiropractic. There are no documented cases of MRSA SSTI stemming from contact with a chiropractor or among chiropractic students (Evans, Ramcharan, Floyd et al., 2009); the phenomenon has not previously been studied. Suspicion of MRSA transmission consistent with amplification (Aiello et al., 2006) was what led me to perform this study.

The incidence of MRSA SSTI in the general population is not known (CDC, 2013c) though it is rapidly expanding (Meddles-Torres et al., 2013). Factors associated with MRSA community transmission are also not sufficiently understood (Lowy, 2013). While no study had previously evaluated MRSA SSTI among chiropractors or chiropractic students, studies have confirmed the presence of MRSA in chiropractic environments (see Table 3)–with some studies finding MRSA on over 20% of the chiropractic tables (Bifero et al., 2006; Puhl et al., 2011). I designed this study to address these gaps through assessment of self-reported MRSA SSTI incidence in a non-outbreak setting among a novel population of interest (a frequent skin contact training program for health professions students with historically poor infection control behaviors).

Review of Studies Related to Constructs and Methods in This Study

In this chapter I discussed the scope of the literature review (relative to databases searched and search terms used) and provided summary findings in table form. I also discussed the epidemiologic triad as a conceptual framework and reviewed attitudes and beliefs in the chiropractic profession, highlighting the strong possibility of MRSA amplification. In this chapter I also reviewed CA-MRSA epidemiology, noting the gap in understanding that this present study addressed. In this section I review studies related to the constructs of interest and methods.

Assessment of diagnosed MRSA SSTI. My study used a questionnaire to confirm reported diagnoses of MRSA SSTI. One recent large study asked high school administrators at all Nebraska high schools (public and private) to confirm by internet-based survey if any players had experienced a diagnosis of MRSA SSTI (Buss & Connolly, 2014). The survey response rate exceeded 70% for 7 of 8 administrations (two sports seasons per year) to between 308 and 312 administrators over each of four school years. The surveys were used to estimate MRSA SSTI attack rates per 10,000 athletes (football players and wrestlers). These were other-reported rather than self-reported diagnoses, but the study paralleled the present study by asking if respondents were aware of a diagnosis rather than relying on records review or active surveillance.

In that study, participants were sent the internet-based survey and two follow-up invitations to participate (Buss & Connolly, 2014). I used this method in my study. The Buss and Connolly (2014) study had administrators report infections that were diagnosed by physicians that the administrators were aware of; the athletes were minors and not directly invited to participate. In my study all participants were directly asked (rather than through an intermediary) if they had experienced a MRSA SSTI diagnosis, which could improve sensitivity over use of an intermediary. That study determined attack rates per 10,000 students per sports season. In my study, I determined incidence of self-reported diagnosis of postmatriculation MRSA SSTI. Questionnaire format will be discussed in Assessment of Risk Factors. As a web-based survey of self-report of physician-diagnosed

MRSA SSTI sent to many respondents representing thousands of athletes, with multiple follow-ups sent to non-respondents, the Buss and Connolly (2014) study contributes and supports the methodology used in my study. That study constructed MRSA SSTI the same way I did: requiring medical diagnosis. That study and my study use a web-based survey with follow-up. Buss and Connolly (2014) achieved high participation and my study sought similar success.

Not utilizing record review within closed medical systems to detect MRSA SSTI (Ellis et al., 2007; Ellis et al., 2014; Ellis et al., 2004; Stevens, A. M., 2010) could lead to some missed MRSA SSTI diagnoses, but would have been extremely impractical in the present case as I assessed chiropractic students across the United States. Participant interviews were not used in my study per Gorwitz et al. (2008)--funded by the U.S. government via NHANES--or per Uhlemann et al. (2011), which was performed within a fixed radius of a single hospital. My study was web-based per Buss and Connolly (2014) for practicality in assessing a large number of participants across the country. As indicated by Wolk et al. (2009), resource considerations are legitimate and sometimes require researchers to use adequate methods that might be enhanced were ideal resources available. For a national, cross-sectional study, the present web-based questionnaire I used to assess self-reported diagnoses of MRSA SSTI was appropriate and consistent with prior research. I used this method in a new population that was suspected to have elevated MRSA transmission and SSTI like the athlete population assessed in Buss and Connolly (2014). Athletes have been suspected of increased transmission for some time (CDC, 2003a, Malachowa, Kobayashi, & DeLeo, 2012). My study assessed chiropractic students, among whom amplification was reasonably suspected but previously unassessed.

Assessment of risk factors. Various methods have been used to assess MRSA risk factors, including retrospective records reviews (Stevens, A. M. et al., 2010), interviews (Gorwitz et al., 2008), or assessment with a questionnaire (Uhlemann et al., 2011). Self-administered risk-factor questionnaires have been used successfully in many studies (Cook, Furuya, Larson, Vasquez, & Lowy, 2007; Miller, L. G. et al., 2007; Morris et al., 2012; Nguyen et al., 2005; Rafee et al., 2012; Uhlemann et al., 2011). None of these methods have been consistently used across all studies in this field. Additionally, there is no universally accepted risk factor questionnaire (Macario et al., 2010). I include studies in Tables 4 and 5 that concern MRSA SSTI risk factors.

While many risk factor studies have been reviewed herein, I will now discuss two studies in depth: Bearman et al. (2010) and Miller, L. G. et al. (2007). These studies are uniquely relevant–the Bearman et al. (2010) study is the largest MRSA study of undergraduate college students (a similar population to my study, though the study concerned nasal carriage). The questionnaire in my study used questions from this questionnaire. The Miller, L. G. et al. (2007) study concerned 180 adult patients with *S. aureus* infections, 108 of which were MRSA (not just SSTI). A research assistant administered a questionnaire in that study. Other studies I previously discussed are briefly mentioned here relative to risk factors, including Ellis et al. (2004), Ellis et al. (2007), and Ellis et al. (2014; performed in U.S. Army trainees); Oller et al. (2010;

college athletes); and Nerby et al. (2011) and Uhlemann et al. (2011; household contacts of MRSA SSTI cases). Again, these studies are noted relative to risk factor assessment.

Bearman et al. (2010) conducted their study over 27 months, collecting prospective surveillance data from 1,000 participants who presented to university-affiliated clinics at a college selected by convenience. Information about risk factors was obtained through use of a data collection form, which I modified and adapted with permission in my study (Appendix F). Miller, L. G. et al. (2007) reported the results of about 40 risk and demographic factors in 108 patients with MRSA infection (not exclusively SSTI). Bearman et al. (2010) examined a similar number of factors, reporting results of about 40 risk factors–if "study population characteristics" are considered, such as pet ownership, sexual activity, educational background, and so forth. The questionnaire used in my study used the exact or very similar wording used by Bearman et al. (2010) to inquire about demographics and specific risk factors. (Healthcare exposures in the present study were assessed through questions derived from the CDC's Invasive Methicillin-Resistant *Staphylococcus Aureus* Active Bacterial Core Surveillance [ABCs] Case Report–2013 [CDC, 2013b], discussed in Appendix G.) Many of the demographic and risk factors included in my study were assessed directly or indirectly in Bearman et al. (2010) and Miller, L. G. et al. (2007): age, gender, race, nation of origin, location, healthcare exposures, hygiene elements (including clothing sharing), intravenous drug use, and jail/incarceration. The risk factor assessment in my study was self-administered as a questionnaire per Bearman et al. (2010) rather than by interviewer per Miller, L. G. et al. (2007)–and was web-based, per Buss and Connolly (2014).

I have already reviewed studies by Ellis et al. (2004), Ellis et al. (2007), and Ellis et al. (2014) in this chapter, and these studies are key literature related to my study. Because of that prior review, it will suffice to indicate that these studies offer important MRSA SSTI incidence data, though in a high-risk population. The incidence of new MRSA SSTI in military trainees, represented as annual rates, ranged from 4.1% (Ellis et al., 2014), to 4.2% (Ellis et al., 2007), to 8.1% (Ellis et al., 2004). Circumstances varied as described earlier, but these studies provide large-scale, prospective incidence data. Data in these studies were obtained by medical records review, which differs from the present study, but the data informed power calculations in Chapter 3.

Oller et al. (2010), Nerby et al. (2011), and Uhlemann et al. (2011) assessed risk factors in participants. The participants were undergraduate athletes (Oller et al., 2010), and (over 70% Hispanic) household contacts of SSTI index cases and controls (Nerby et al., 2011; Uhlemann et al., 2011). Each of these studies also had limited generalizability beyond the study populations. Risk factors were assessed by questionnaire (Oller et al., 2010) like my study; records review and interviewing (Nerby et al., 2011); as well as by audio computer-assisted self-interviewing (Uhlemann et al., 2011). In the latter case, this tool was explicitly used for more sensitive questions.

Though some authors–such as Uhlemann et al. (2011)–indicated that specific methods were undertaken to help participants disclose sensitive information, none indicated that they independently validated participants' self-reported responses. Expense and practical and ethical concerns typically limit independent validation of self-report information (Brener et al., 2003). In one study, physician specialists directly examined the nares for signs of nose-picking in participants in an ear, nose, and throat clinic to validate self-report information, but this is not the norm in MRSA risk factor studies (Wertheim et al., 2006). However, self-reported information still offers key data that would otherwise be difficult to obtain, and questionnaires of even sensitive items are able to obtain valid data, even if not independently verified (Brener et al., 2003; Zimmerman & Langer, 1995). My study–consistent with all cited throughout except Wertheim et al. (2006)–did not independently validate self-reported information.

To facilitate honest self-reporting and enhance validity, risk factor questionnaires can be constructed to reduce participants' situational and cognitive burdens (Brener et al., 2003). Some methods I used in this study that facilitated this included self-interviewing and the wording and order of questions–for example, earlier questions of lower sensitivity assisting the respondent to remain forthright during later, more sensitive questions (Blair et al., 1977; Bradburn, Sudman, Blair, & Stocking, 1978; Johnson, 1970; Tourangeau & Smith, 1998). Yes/no questions were used, as they can produce more accurate data with sensitive questions (Gmel & Lokosha, 2000), and question format appears more important than social norms to participant responses (Bradburn et al., 1978). Yes/no questions (did a behavior occur?) are easier to interpret than frequency questions (how often did a behavior occur?), facilitate response when asked in series, and are aided by reference to a shorter timeframe (such as less than 12 months) (Blair et al., 1977; Brener et al., 2003; Tourangeau & Smith, 1998). My study questionnaire (Appendix A) largely asked yes/no questions–many related to the previous 12 months or to demographics. The accuracy of self-reporting should be enhanced by this literature-based construction of the questionnaire (Johnson, 1970; Tourangeau & Smith, 1998) conducted via secure, web-based survey (Buss & Connolly, 2014; Crutzen & Göritz, 2011) through Qualtrics (QLite version).

The sense of privacy, legitimacy, and confidentiality engendered in the process surrounding self-interviewing with the questionnaire makes a critical difference (Brener et al., 2003; Johnson, 1970). Self-administered questionnaires may have this advantage over interviewer-assisted questionnaires (Aquilino et al., 1998; Tourangeau & Smith, 1998). However, in adults, there are mixed findings; there may not be a preference in interview method as long as confidentiality is preserved (Aquilino et al., 1998; Crutzen & Göritz, 2011; Macario et al., 2010; Tourangeau & Smith, 1998; Wu et al., 2009).

A variety of risk factor studies regarding hospital-based or invasive MRSA infection have been conducted, some of them pivotal (Klevens et al., 2006; Naimi et al., 2003). One case-control risk factor study was conducted among prisoners (Maree et al., 2010), and studies among prisoners (related to SSTI, carriage, and outbreak investigations) were reviewed by Malcolm (2011). Community-based infections are not declining (Dantes et al., 2013) but have increased 84% in just a few years (Meddles-Torres et al., 2013). However, the prevalence of MRSA SSTI in the community is unknown (CDC, 2013c), and risk factors for transmission require further study (Lowy, 2013). There are no nationally representative data for MRSA SSTI risk factors in the community.

Uhlemann et al. (2011), while incorporating a case-control element and using MRSA genotypic analysis as well as environmental sampling, had a largely Hispanic population of household contacts of individuals diagnosed with MRSA infection–not a typical community population. Nerby et al. (2011) assessed for clonal isolates in 236 index cases with SSTI and 712 household contacts with colonization, and found use of antimicrobial soap protective of carriage in self after treatment for SSTI (*OR* 0.44, 95% *CI* [0.24, 0.78], remaining significant in multivariable analysis) and sharing of lotions associated with clonal carriage with a household contact (*OR* 1.95, 95% *CI* [1.18, 3.22]). This study helped support the inclusion of shared lotion as a risk factor in my study, but the Nerby et al. (2011) study did specimen collection long after the index case was detected, potentially effecting their results. The biological assessment of the index patient was 69 days after SSTI and the household contact was 64 days after the infection report–and though 12% of household contacts were colonized, there was a low household enrollment rate (30%). Of additional importance in that study, frequency of hand washing was not evaluated, and this is an important potential confounder to consider regarding the reported protective effect of antimicrobial soap.

Ellis et al. (2007), while performing a prospective study that included a randomizing element and MRSA genotypic analysis, performed the study in a non-representative group for typical community members: United States Army trainees. Oller et al. (2010), while comparing two athletic teams and a control group of non-athletes at the same university, did not assess many risk factors and did not report all of the data on the limited number of factors they assessed. Miller, L. G., et al. (2007) powered the study to detect risk factors associated with CA-MRSA SSTI as opposed to MSSA infection, but performed the study in recently hospitalized patients with blood, sputum, urine, and wound cultures, not just SSTI. Both Miller, L. G. et al. (2007) and Bearman et al. (2010) assessed about 40 risk factors, introducing the possibility of Type I error. While I will further discuss strengths and weaknesses of various approaches in Evaluation of Strengths and Weaknesses of Various Approaches, my study drew from the strengths of the evaluated studies and use web-based, self-administered questionnaires; self-reported diagnoses of MRSA SSTI; a limited set of risk factors to reduce Type I error; and a non-mixed population (100% chiropractic students).

Summary: Review of studies related to constructs and methods in this study. The feasibility of a larger-scale, multisite, reported SSTI diagnosis, web-based questionnaire was reviewed (Buss & Connolly, 2014). Macario et al. (2010) showed the lack of a standard risk factor questionnaire, but self-administered risk questionnaires were frequently used--as seen in several studies reviewed here. Bearman et al. (2010) evaluated about 40 risk factors in a mostly undergraduate student population–portions of the questionnaire used by these resources were used in my study. Self-reported data are difficult to independently validate; however, self-reporting is an irreplaceable method for data collection. Methods to improve responses to sensitive questions were discussed from the literature (Blair et al., 1977; Bradburn et al., 1978; Brener et al., 2003).

Evaluation of Strengths and Weaknesses of Previous Approaches

The data in the present study could have been acquired through a variety of methods. Each possible method has been used in prior studies, each with strengths and weaknesses. Several prior approaches and the strengths and weaknesses of each are reviewed in Table 6.

Table 6

Strengths and Weaknesses of Prior MRSA Assessment Methods Related to This Study

Method	Strengths	Weaknesses
Nasal carriage only	Comparable to national standardized data from NHANES (Gorwitz et al., 2008; Kuehnert et al., 2006); easy to perform and minimally invasive; similar to many prior studies in college students (Bearman et al., 2010; Creech et al., 2010; Rohde, Denham, & Brannon, 2009) and other populations (Ellis et al., 2004; Rafee et al., 2012)	Not the sole potential carriage site (Yang et al., 2010; Miller, L. G. et al., 2012); difficulty of national assessment–national assessment not performed since Gorwitz et al. (2008); nasal carriage relationship to SSTI still unclear (see Table 5); carriage can be detected at levels that would not be cultureable and may never produce infection, the real outcome of interest (Ridgway et al., 2013)
Other body site carriage (axillary, anovaginal, perineal, inguinal)	Other body sites can be sources of carriage, including anovaginal (Top et al., 2010), inguinal (Miller, L. G. et al., 2012; Yang et al., 2010); axillary (Yang et al., 2010); rectal (Yang et al., 2010); and oropharyngeal (Miller, L. G. et al., 2012) sites	More invasive to assess other sites (Miller, L. G. et al., 2012), which could impact participation and introduce consent bias (Porta, 2008); additional cost to assess additional sites; noncomparable to the largest studies (all nasal) (Bearman et al., 2010; Ellis et al., 2007; Ellis et al., 2004; Gorwitz et al., 2008)
Self-reported diagnoses of MRSA SSTI	Surveillance at hundreds of locations using a web-based survey (Buss & Connolly, 2014) captures attack rate across thousands; questionnaires can obtain sensitive information accurately (Blair et al., 1977; Brener et al., 2003; Gmel & Lakosha, 2000; Tourangeau & Smith, 1998); participants will use web questionnaires (Buss & Connolly, 2014; Crutzen & Göritz, 2011	Some SSTI might be undiagnosed, uncultured, or unreported (e.g., Ellis et al., 2007, where many infections were not cultured); reporting by individuals risks social desirability bias (Bradburn et al., 2004), though web-based, confidential reporting helps (Crutzen & Göritz, 2011)
Medical record review for MRSA SSTI diagnoses	Whole system and catchment areas can be assessed (Ridgway et al., 2013; Stevens, A. M. et al., 2010; Talan et al., 2011)	Potential misclassification, potential loss to follow-up, and cultures that may not have been for SSTI (Ridgway et al., 2013); requires access to the system, which may require employment by the system (Department of Veterans Affairs, 2014); records systems capable of capturing all patient healthcare may not represent typical patients (Stevens, A. M., et al., 2010)
Prospective assessment of MRSA SSTI in closed-systems	Military trainees who could not obtain off-base medical care (Ellis et al., 2007; Ellis et al., 2014; Ellis et al., 2004) provide unique insight into prospective SSTI risk	Not all persons in the system area may have reported for care of SSTI, and some may have left the system for care (Ellis et al., 2004; Stevens, A. M. et al., 2010); closed-system populations may not generalize to the general U.S. population (Ellis et al., 2007; Ellis et al., 2014; Ellis et al., 2004; Stevens, A. M., et al., 2010)
Single assessment	Relative ease and lower cost–studies in college students using single assessment include Rackham, Ray, Franks, Bielak, & Pinn (2010), Rohde et al. (2009), Slifka et al. (2009), and Chamberlain & Singh, (2011)	Lack of prospective, longitudinal element prohibits any determination of causality or risk attribution (Porta, 2008); no discovery of transient colonization in colonization studies (Bearman et al., 2010)
Repeated assessment	Prospective, longitudinal element can permit causality determination, discovery of transient colonization, and risk attribution (Bearman et al., 2010; Creech et al., 2010)	Costlier; specimens and questionnaires must be linked to one another for longitudinal assessment, increasing the administrative burden and confidentiality risks (Bearman et al., 2010); nationally representative studies such as NHANES permit assessment of trend, but cannot tie risk factors to infection as individuals were not reassessed over time (Gorwitz et al., 2008)

Note. MRSA = methicillin resistant *Staphylococcus aureus*; SSTI = skin and soft tissue infection; NHANES = National Health and Nutrition Examination Survey.

Justification of Chosen Variables

Major dependent and independent variables in the my study include self-reported diagnosis of MRSA SSTI, stage of education, sharing of lotions and patient gowns, and frequency of hand and table hygiene (see Tables 4 and 5). I briefly provide literature-based justification for each variable here.

MRSA SSTI–a person element per the epidemiologic triad–is the dependent variable of interest. MRSA is a community threat. The rate of pediatric MRSA hospitalizations in the US increased over 25 times from 1996 to 2006, reaching 25.5 cases per 100,000 in 2006 (Frei et al., 2010); invasive MRSA ranks as one of the most significant causes of infectious disease mortality in the US, killing over 18,000 per year (DeLeo et al., 2010; Klevens et al., 2007); MRSA-related hospitalizations for community-associated infections increased 7 times from 0.4 in 1998 to 3.1 per 1,000 discharges in 2007 (Mera et al., 2011); noninvasive MRSA infection incidence per 100,000 veterans in one Veterans Affairs healthcare system increased four-fold from 2000 to 2008 from 100 to 397 cases (Tracy et al., 2011); and MRSA is the most common cause of cultured SSTI in US emergency rooms (Moran et al., 2006; Talan et al., 2011) and primary care clinics (Parchman and Munoz, 2009). Researchers need to explore additional routes of community transmission (Lowy, 2013). Chiropractic students represented a population with characteristics consistent with the principle of amplification (Aiello et al., 2006) secondary to infection control beliefs and behaviors outlined here. MRSA SSTI and associated infection control and other risk factors in chiropractic students had not been explored–I addressed that gap with the present study.

Stage of chiropractic education, an independent variable representing the time element of the epidemiologic triad, reflected the possibility of increasing training exposure affording opportunity for MRSA transmission, particularly on initiation of patient care. Studies of healthcare students have variably found that later year students and interns may have increased MRSA exposure compared to earlier students because of participation in clinical settings (Güçlü et al., 2007; Ishihara et al., 2010; Piechowicz, Garbacz, Wiśniewska, & Dąbrowska-Szponar, 2011; Renushri, Nagaraj, & Krishnamurthy, 2011; Slifka et al., 2009; Zakai, 2015), though only one of those studies was performed within the United States (Slifka et al., 2009) (see Appendix E). Year of study did not have a significant effect in the Slifka et al. (2009) study, though the sample size may have impacted power to detect a difference. My study attempted to collect data from a deliberately powered sample. In my study, I assessed if stage of chiropractic education was associated with diagnosed MRSA SSTI.

Sharing of lotions, sharing of patient practice gowns, and frequency of hand and table hygiene were also independent variables in my study, representing person factors in the epidemiologic triad. Control variables in my study included these other person variables per the triad: age, gender, healthcare exposures, military service, jail, and intravenous drug use. Control variables in my study included these place variables per the epidemiologic triad: chiropractic college campus and nation of origin.

While many risk factors for CA-MRSA SSTI have been explored (see Tables 4 and 5 in this chapter), my study tailored exploration to independent variables linked to prior SSTI research and of potential importance to the chiropractic student population.

Nerby et al. (2011) found a protective effect from antimicrobial soap usage in household contacts of index SSTI cases, but did not evaluate usage frequency–my study did. These authors also found an association between sharing lotion with case patients and MRSA transmission. The questionnaire I used in this study drew on the questionnaire used by Bearman et al. (2010). Mild adaptation of a question admitted assessment of sharing of lotion per Nerby et al. (2012) and sharing of the patient practice gown, similar to Bearman et al. (2010) who assessed sharing of clothing. Questions on hand and table hygiene frequency were from Evans and Breshears (2007). Questions on healthcare exposures stemmed from the CDC (2013b). There is no standard CA-MRSA risk factor questionnaire (Macario et al., 2010).

Review and Synthesis of Studies Related to the Research Questions

The study research questions address gaps discovered via a literature review.

RQ1. Is frequency of hand hygiene (frequent vs. infrequent) between practice partners and patients significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI?

RQ2. Is frequency of treatment table hygiene (frequent vs. infrequent) between practice partners significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI?

RQ3. Is sharing of lotions, emollients, and lubricants significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI?

RQ4. Is sharing of patient practice gowns significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI?

RQ5. Is stage of chiropractic education (institution of patient care or not) significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI?

I review and synthesize studies related to each question here.

Stage or year of education has been explored in studies of MRSA in students of the health professions, particularly internationally (Chamberlain & Singh, 2011; Güçlü et al., 2007; Ishihara et al., 2010; Kim, Yim, & Jeon, 2015; Piechowicz et al., 2011; Renushri et al., 2011; Slifka et al., 2009; Treesirichod, Hantagool, & Prommalikit, 2014; Trépanier, Tremblay, & Ruest, 2013; Zakai, 2015). Findings were mixed–some reported potential relationships with transmission increases (Güçlü et al., 2007; Ishihara et al., 2010; Piechowicz et al., 2011; Zakai, 2015), some no relationship (Slifka et al., 2009; Treesirichod et al., 2014; Trépanier et al., 2013), but none a negative relationship. It was a logical extension to assess this in chiropractic education, a high skin-contact training program among individuals with health beliefs and practices counter to mainstream infection control who will graduate and touch millions of community-member patients.

The concept of reported SSTI diagnosis is per Buss and Connolly (2014). The assessed risk factors were similar in Bearman et al. (2010) and Evans and Breshears (2007), both of which supplied questions for my questionnaire. The former study supplied questions related to sharing clothing and lotion with minimal modification. The latter supplied questions related to hand and table hygiene with minimal modification. I assessed healthcare exposure risk factors in my study per the CDC (2013b) questionnaire with minimal modification. I discuss these questionnaires and their use in the present study further in the appendices (see Appendices F, G, and H).

Bearman et al. (2010) excluded participants with prior MRSA infection; my study did not. Excluding prior infection in the Bearman et al. (2010) study showed intent to capture only CA-MRSA. Prior infection is an HRF or healthcare exposure in epidemiologic definitions (CDC, 2010, 2013b; Klevens et al., 2006; McDougal et al., 2010; Skov et al. 2012). Bearman et al. (2010) also excluded other HRFs. In my study, I assessed healthcare exposures in the 12 months prior (CDC, 2010, 2013b; Klevens et al., 2006; McDougal et al., 2010), including prior MRSA SSTI (CDC, 2013b; Ridgway et al., 2013), as control variables. My questionnaire (Appendix A) drew from the sources noted because there is no standard CA-MRSA risk factor questionnaire (Macario et al., 2010). Bearman et al. (2010) used pregnancy and breastfeeding as exclusion criteria, likely required by the IRB, as MRSA carriers were provided medication in that protocol. My study did not provide medication and did not ask about these traits.

Few studies of MRSA SSTI outside of outbreaks have been conducted in college students (Creech et al., 2010), though large studies among college-aged military trainees have been conducted (Ellis et al., 2007; Ellis et al., 2014; Ellis et al., 2004). As noted, I review a variety of risk factors assessed in these and other studies in Tables 4 and 5.

Questions posed by Bearman et al. (2010) were used in the same or similar format in my study. The Bearman et al. (2010) study included 110 nonstudents and did not report confidence intervals on risk factors. The present study used only students and provided confidence intervals. My study asked about fewer risk factors than Miller L. G. et al. (2007) and Bearman et al. (2010) who asked about approximately 40 risk factors, perhaps introducing Type I error.

Though special populations such as athletes and military trainees have been assessed relative to MRSA SSTI, studies had not been performed among chiropractic students. However, the fact that these students will graduate and have millions of patient contacts (Barnes et al., 2008; Davis et al., 2009; Peterson & Bergmann, 2002), yet have health beliefs and behaviors inconsistent with mainstream infection control, drove me to perform the current study and provided an opportunity to evoke positive social change (Evans, Ramcharan, Ndetan et al., 2009). I built on previous work with my research by extending this line of questioning into a novel population that was reasonable to assess given population and organism characteristics (skin contact, poor use and appreciation of clinical hygiene due to health beliefs, pathogen transmission by skin and fomite, and pathogenic production of SSTI), and given the lack of community incidence data.

Summary and Conclusions

In this chapter I reviewed literature related to CA-MRSA epidemiology, particularly of MRSA SSTI. I reviewed the conceptual framework of the epidemiologic triad. I discussed chiropractic infection control attitudes and behaviors and MRSA epidemiology. I reviewed CA-MRSA assessment methods. Key themes were as follows:

- Hand and clinical hygiene appear to be meaningful components of CA-MRSA infection control, but chiropractors and chiropractic students have not shown a profound or consistent appreciation for the role of infection control or clinical hygiene and MRSA has been detected on over 20% of chiropractic tables;

- CA-MRSA epidemiology changed significantly in the first decade of the 21st century, with USA300 particularly displaying increased virulence;
- CA-MRSA is the most common cause of cultured SSTI in the United States;
- Factors associated with MRSA SSTI in the community are not fully understood, rendering community transmission control problematic;
- Many populations have been assessed for CA-MRSA SSTI;
- However, though chiropractic students train with hand/skin contact with one another for hundreds of hours in their educational process, graduate to have skin contact with millions of patients per year, and often have health attitudes and behaviors inconsistent with mainstream infection control practice, MRSA SSTI and associated risk factors had not been assessed in this population.

Through the present study, I began to address these gaps (and expand knowledge in the field of MRSA epidemiology), grounded in the epidemiologic triad: (a) incidence of reported MRSA SSTI in a population of U.S. chiropractic students, (b) associated and potentially modifiable infection control risk factors for MRSA SSTI, and (c) the association between stage of education and self-reported MRSA SSTI in these students. My study may reinforce the ACA hygiene policy and increase appreciation of the role of infection control behaviors in a community population at risk for MRSA amplification. In Chapter 3 I review the methods used in the present study to address these gaps in knowledge.

Chapter 3: Research Method

Through this quantitative, cross-sectional study I provided the first assessment of self-reported MRSA SSTI incidence in chiropractic students, as well as the correlation between SSTI and hygiene behaviors (frequency of hand and table hygiene, sharing of lotions/lubricants, and sharing of patient practice gowns) and stage of education, controlling for age, race, gender, nation of origin, healthcare exposures (prior MRSA SSTI, surgery, hospitalization, central venous catheterization, residence in a long term care facility, and dialysis), military service, jail, and intravenous drug use. My purpose was to understand how infection control behaviors modified MRSA SSTI risk in this group with frequent skin contact during training that has not historically endorsed mainstream infection control practices. In this chapter, I discuss the research design and rationale, methodology, threats to validity, and ethical procedures for the present study.

Research Design and Rationale

This study was cross-sectional with a novel population to allow me to capture a broad assessment that could reveal the need for future analytic and surveillance studies (Merrill, 2013). I used self-reported diagnosis of MRSA SSTI as the variable of interest, consistent with another large-scale representative study of reported MRSA SSTI in high school athletes (Buss & Connolly, 2014). This study was cross-sectional, consistent with other survey-based MRSA assessments (Bearman et al., 2010; Gorwitz et al., 2008). I conducted this study with 9 of 18 U.S. chiropractic campuses. Future studies can conduct longitudinal, active surveillance across additional campuses, health professions, or nations for comparison. Future studies could also use medical records to identify additional cases of MRSA SSTI or could assess the hygiene practices and SSTI among chiropractic graduates. My variable of interest was self-reported diagnosis of MRSA SSTI in chiropractic students, of particular interest as it is actual infection instead of asymptomatic carriage and in a novel population where amplification is suspected. The methods of this study are broadly representative of U.S. chiropractic students and allowed me to assess the phenomenon across all participating U.S. chiropractic colleges. I used the survey to assess the demographics, risk factors, and variables of interest.

I used a literature-based, self-administered questionnaire to collect demographics and risk factors (self-reported diagnoses of MRSA SSTI, stage of education, sharing of lotion and patient practice gowns, and frequency of hand and table hygiene)–all of which were study variables. I performed univariate assessment of risk factors; tested for interaction with control variables including age, race, gender, country of origin, jail, military service, intravenous drug use, healthcare exposures (hospitalization, surgery, residence in a long term care facility, central venous catheterization, dialysis, and prior MRSA SSTI), and college location; and produced a final logistic regression model of self-reported MRSA SSTI to assess the strength of the relationship between variables, controlling for assessed confounders. This contributed to efforts to understand MRSA SSTI in the community.

I conducted this study as I felt that data from this study could reveal the need for longitudinal studies with these and other students of the health professions. I felt this cross-sectional, survey-based study offered the potential to reveal phenomena that would need to be considered in future analytic and longitudinal studies in this population. The study design was capable of furthering understanding of MRSA, an entity with multiple definitions (genetic, phenotypic, and epidemiologic; Popovich, Hota, Rice, Aroutcheva, & Weinstein, 2007; Skov et al., 2012; Tenover et al., 2006), varying impact in multiple populations, and critical importance (CDC, 2013a)—and which is still poorly understood in the community (Dantes et al., 2013; Lowy, 2013).

Methodology

Sample

The target population was all chiropractic students attending a U.S. chiropractic college, except my employing chiropractic college (NYCC), which was excluded for ethical purposes. The target population size was ≈9,000, the number of U.S. chiropractic students in 2013 excluding NYCC (McCoy Press, 2013). A census was drawn–that is, the entire target population attending all participating chiropractic colleges was invited. This resulted in an invited pool of about 40% of all U.S. chiropractic students, seeking enrollment of 370–see Power Analysis. The sampling frame consisted of all matriculated chiropractic students attending 9 of 18 U.S. chiropractic college campuses (the exact total number of students will not be revealed, to prevent identifying participating campuses–the number was ≈40% of all U.S. chiropractic students). Students were excluded from the sampling frame if they were not a currently enrolled chiropractic student, were 17 or younger, or were 65 or older, which was rare.

Power Analysis

The overall incidence of MRSA SSTI is not known (CDC, 2013c). The incidence of diagnosed MRSA SSTI in prospective studies has ranged from 0.79% in 126 college athletes over a year (Creech et al., 2010), to 1.4% in 812 military trainees over 8 to 10 weeks (an annualized rate of 8.1%; Ellis et al., 2004), to 1.3% in 3,066 military trainees with some intervention over 16 weeks (an annualized rate of 4.2%; Ellis et al., 2007), to 1.1% in 30,209 military trainees with some intervention over 14 weeks (an annualized rate of 4.1%; Ellis et al., 2014). One population-based study of over 3 million people estimated that clinical diagnoses of SSTI were 496 per 10,000 person years, with 37% of these diagnoses being MRSA, yielding an annual incidence of 1.8% (Ray et al., 2013). Another study of MRSA infection in a 4-hospital system found the annual incidence of any MRSA infection to be 0.6% to 8% in groups with varying risks, with some groups having higher rates (Ridgway et al., 2013). MRSA SSTI incidence among chiropractic students was unknown, although the MRSA contamination rate on chiropractic tables has exceeded 20% (Bifero et al., 2006; Puhl et al., 2011). Without baseline population data (CDC, 2013c), these data allowed estimates for power calculations.

For this study, I assumed the annual incidence for students without risk factor exposures was 1.8%, per Ray et al. (2013). Students were assumed to have attended chiropractic college 1.5 years out of the 5-year program (NBCE, 2010; NYCC, 2010), so the annual rate was multiplied by 1.5, yielding a postmatriculation incidence estimate in this chiropractic college population of 2.7% (1.8% x 1.5; Ray et al., 2013). I used an alpha of 0.05 and p of 0.05 for calculations, standard for two-tailed tests for significance. Power calculations shown in Table 7 reveal the number of participants needed to achieve 80% power given these factors. All power calculations were performed using OpenEpi (version 3.03) “Power for Cross-Sectional Studies” (Dean et al., 2014).

Table 7

Power Calculations for Study Risk Factors

Risk	Sample size	Risk factor (%)	Participants with risk factor	Participants without risk factor	Incidence of reported MRSA SSTI with risk factor (%)	Incidence of reported MRSA SSTI without risk factor (%)	Power (%)
Hand hygiene	1190	22	261	929	6.3[a]	2.7[b]	80.04
	400	22	88	312	6.3	1.2[c]	80.35
	240	**22**	**52**	**188**	**12[d]**	**2.7**	**80.36**
	134	22	29	105	12	1.2	80.3
Table hygiene	1470	71	1043	427	6.3	2.7	80.26
	675	71	479	196	6.3	1.2	80.33
	370	**71**	**262**	**108**	**12**	**2.7**	**80.27**
	260	71	184	76	12	1.2	80.03
Sharing lotion, emollient, lubricant	1010	42.4	428	582	6.3	2.7	80.34
	400	42.4	169	231	6.3	1.2	80.14
	230	**42.4**	**97**	**133**	**12**	**2.7**	**80.4**
	150	42.4	63	87	12	1.2	80.81
Sharing patient practice gowns	1100	25.5	290	810	6.3	2.7	80.2
	385	25.5	98	287	6.3	1.2	80.0
	230	**25.5**	**58**	**172**	**12**	**2.7**	**80.32**
	130	25.5	33	102	12	1.2	80.85
Stage of education	1000	40	400	600	6.3	2.7	80.04
	395	40	158	237	6.3	1.2	80.32
	225	**40**	**90**	**135**	**12**	**2.7**	**80.04**
	146	40	58	88	12	1.2	80.7

Note. MRSA = methicillin resistant *Staphylococcus aureus*; SSTI = skin and soft tissue infection. All calculations performed with alpha = 0.05, given a two-tailed test, $p = 0.05$, and normal approximation. Calculations used power for cross-sectional studies function of www.openepi.com using confidence interval, two-sided = 95. (http://www.openepi.com/v37/Power/PowerCross.htm). Calculated in openepi.com (version 3.03) (Dean, Sullivan, & Soe, 2014). Power calculations presented with 4 different estimates of MRSA SSTI rates. Boldface values used by the study.

[a]6.3% is the 4.2% annualized rate in Ellis et al. (2007), multiplied by 1.5 years (an estimate of the average length of time respondents will have attended their 5-year chiropractic programs)–yielding a postmatriculation incidence. [b]2.7% is the 1.8% annual rate in Ray et al. (2013), also multiplied by 1.5 years. [c]1.2% is the 0.79% annual rate in Creech et al. (2010), also multiplied by 1.5 years. [d]12% is the 8% annual rate in Ridgeway et al. (2013) and the 8.1% annualized rate in Ellis et al. (2004), also multiplied by 1.5 years.

Frequency of hand hygiene (RQ1). With alpha = 0.05, $p = 0.05$, and $n = 240$, power is 80.36%. This was based on my assumption that frequency of hand hygiene is per the survey among 773 chiropractic students at three chiropractic campuses (Evans, Ramcharan, Ndetan et al., 2009). In that survey 78% of students reported *always* and *frequently* sanitizing hands between patients. In these calculations 78% of students were assumed to be frequent hand sanitizers with 2.7% incidence of self-reported postmatriculation MRSA SSTI, and 22% were assumed to be infrequent sanitizers with 12% incidence of postmatriculation MRSA SSTI. I attempted to recruit 370 participants for RQ2, which would provide adequate power for this question (RQ1), which required 240 participants (see Table 7). The sources of these values were described above; no comparable data in educational settings exist. One hospital study found that increased hand hygiene compliance among healthcare workers reduced healthcare infections in patients from 0.52 to 0.24 per 1,000 patient days (Lederer, Best, & Hendrix, 2009). If students in high-contact training environments had attack rates of 0.24 per 1,000 student days, a class of 100 students would have ≈8.54 infections per year, or 8.54%. A study of diagnosed MRSA SSTI among high school athletes reported by coaches at the end of the season found an estimated rate as high as 0.61% per season (shorter than a year) among wrestlers (Buss & Connolly, 2014). The estimated values used in my study are postmatriculation--a multiyear incidence. These values were reasonable in the absence of general incidence information.

Frequency of table hygiene (RQ2). With alpha = 0.05, $p = 0.05$, and $n = 370$, power is 80.27%. This was based on my assumption that frequency of table hygiene was per the survey among 773 chiropractic students at three chiropractic campuses (Evans, Ramcharan, Ndetan et al., 2009). In that survey 29% of students reported that they *always* and *frequently* sanitized tables between patients. In power calculations 29% of students were assumed to be frequent table sanitizers with 2.7% incidence of self-reported postmatriculation MRSA SSTI, and 71% of students were assumed to be infrequent sanitizers with a 12% incidence of postmatriculation MRSA SSTI (see Table 7). The target of 370 students is based on the power needed for this question (RQ2). These values were reasonable in the absence of incidence data in this or the general population as described. Environmental contamination in chiropractic educational and practice settings have already been outlined, with studies finding MRSA on over 20% of tables in some studies (Bifero et al., 2006; Puhl et al., 2011).

Sharing of lotions, emollients, and lubricants (RQ3). With alpha = 0.05, p = 0.05, and n = 230, power is 80.4%. This was based on my assumption that frequency of sharing lotions was similar to the number of undergraduates who reported sharing bar soap in their households (42.4%; Bearman et al., 2010). In power calculations 42.4% of students were assumed to share lotion with 12% incidence of any self-reported postmatriculation MRSA SSTI, and 57.6% of students were assumed to be nonsharers of lotion with a 2.7% incidence of postmatriculation MRSA SSTI. I sought to recruit 370 participants to adequately power the study for RQ2, which would also provide adequate power for this question (RQ3; see Table 7). The sources of these research-based values were described above. Nerby et al. (2011) reported that household contacts of index pediatric MRSA cases were likely (*OR* = 1.95, 95% *CI* [1.18, 3.22]) to carry clonally related MRSA if they applied lotion to the contact. There are no SSTI effect size estimates for this risk factor in the present study, so these literature-based estimates were substituted.

Sharing of patient practice gowns (RQ4). With alpha = 0.05, $p = 0.05$, and $n = 230$, power is 80.32%. This was based on my assumption that frequency of sharing gowns was per the rate of sharing clothing (25.5%) in households among undergraduate students (Bearman et al., 2010). In power calculations for my study I assumed the incidence of any self-reported postmatriculation MRSA SSTI among those who shared gowns was 12% and incidence of any postmatriculation MRSA SSTI among the 74.5% assumed to be nongown sharers was 2.7%. I attempted to recruit 370 participants to adequately power this study for RQ2, which would also provide adequate power for this question (RQ4; see Table 7). The sources of these values were described above. Guidance for the general population, athletes, and others is to avoid sharing personal items (CDC, 2013c). There is no published effect size information related to sharing clothing and MRSA SSTI, so these literature-based estimates were substituted.

Stage of education (initiation of patient care or not) (RQ5). With alpha = 0.05, $p = 0.05$, and $n = 225$, power is 80.04%. This was based on my assumption that 60% of students would be preclinical and 40% of students would be clinical, approximately equal to the percentage of students in these stages of their programs, whether semester- or quarter-based (NBCE, 2010; NYCC, 2010). Therefore, 40% of students were assumed to be at a stage of education with patient care (clinical) with a 12% incidence of any self-reported postmatriculation MRSA SSTI. Conversely, 60% of students were assumed to be preclinical with a 2.7% incidence of MRSA SSTI. I attempted to recruit 370 participants to adequately power the study for RQ2, which would also provide adequate power for this question (RQ5; see Table 7). The sources of these values were described above. MRSA has been found on over 20% of examined chiropractic tables (Bifero et al., 2006; Puhl et al., 2011), a contamination rate that parallels that of privacy curtains in hospital intensive care units and medical wards (Ohl et al., 2012). There are no studies of MRSA SSTI in U.S. medical students, but there are studies of MRSA nasal carriage. One study found no increase in MRSA nasal carriage in students as they enter clinical care (nonsignificant increase detected in an underpowered study) in U.S. medical students (Slifka et al., 2009); both significant and nonsignificant increases in carriage in international healthcare professions students have been detected (see Appendix D). I sought adequate power to detect a difference in MRSA SSTI in preclinical and clinical students and thereby contribute to the literature.

Summary. Inviting the entire sampling frame as a census--all students attending half of all U.S. chiropractic college campuses--and seeking to enroll 370 students represented an appropriate research-based strategy to deal with the unknowns, and to achieve at least 80% power with alpha = 0.05 and $p = 0.05$ for the research questions. There were no incidence data for MRSA SSTI in the general population (CDC, 2013c). Incidence data derived from prospective studies of MRSA SSTI in undergraduate athletes, military personnel, and a health network were used to generate conservative annual incidence estimates. Literature was provided to support the estimates. As a first foray into this population, I determined that seeking 370 surveys from chiropractic students attending 9 of 18 U.S. chiropractic college campuses would provide a broad assessment of these factors and permit assessment of the relationship between infection control factors and MRSA SSTI in chiropractic students and provide incidence data regarding self-reported MRSA SSTI in a nonoutbreak setting.

The Bearman et al. (2010) study was the largest study of risk factors in college students, but the study included 110 nonstudents, included about 40 demographic and risk factors without correcting for the possibility of Type I error, and regarded carriage. Other studies of SSTI risk factors have noted the risk of Type I error when assessing many risk factors (Miller, L. G. et al., 2012)–but were not conducted in college students. I built on prior studies with this study by assessing a specifically limited number of MRSA SSTI risk factors as independent variables among the chiropractic student population of interest (stage of study, sharing of practice gowns and lotion, and frequency of hand and table hygiene). The variables were included as they were of substantial interest to chiropractic students and amplification was suspected.

Inquiring about a limited set of factors minimized the risk of Type I error in my study. Additionally, my study built on others regarding MRSA SSTI that have conducted power analyses (Ellis et al., 2014; Miller, L. G. et al., 2007) and was among the first to power a risk factor assessment study in a nonoutbreak, community setting. Prior cross-sectional studies of MRSA risk factors have not considered effect size in determining the number of participants (Gorwitz et al., 2008; Miller, L. G. et al., 2012), though Miller, L. G. et al. (2012) followed all eligible cases over the study period and Gorwitz et al., (2008) attempted to assess MRSA nasal carriage with a nationally representative sample.

This study was the first assessment of MRSA SSTI in a chiropractic student population, a novel population with suspected amplification.

Procedures for Recruitment, Participation, and Data Collection

This study recruited students from participating U.S. chiropractic colleges, achieving participation from 9 of 18 campuses. My employing chiropractic college was not included to avoid ethical concerns. The study methods and IRB approval required at least 3 colleges, which was achieved. The study used survey data collected from these students as well as general demographics of chiropractic students–such as age, race, nation of origin, and gender. In this section I will describe recruitment, consent, data collection, and study exit.

Recruiting procedures. All students were emailed study information and the informed consent form for review. At least 48 hours later, the first emails with answerable forms and surveys were emailed with additional appeals two additional times at least four days apart (for a total of three appeals). The original protocol allowed up to five appeals, if 370 surveys were not received. Demographics included age, race, gender, nation of origin, and campus. General demographics were used to assess differences in participants and nonparticipants. Participant information is confidential.

Informed consent and data collection. As noted, an informational email and read-only informed consent form were emailed to all students. The first Qualtrics (QLite version) email that permitted consent and participation was sent at least 48 hours after so each student could weigh costs and benefits before enrolling. Participants could not access the survey without providing electronic consent. The informed consent form included my contact information to permit asking questions (as informed consent is more than a form). The informed consent form included the IRB-approved language. Students were encouraged to retain a copy. Email questions during the study period were responded to within 24 hours.

After willing participants clicked their consent, internal logic advanced the survey. The Qualtrics (QLite version) questionnaire included inclusion/exclusion criteria questions, a basic demographics questionnaire, and the survey. Internal logic advanced included participants within the questionnaire, further described below and included in Appendix A. Internal logic thanked excluded participants for their time, and thanked included participants who completed the survey. Students who were 17 or under or 65 or older, or who were not chiropractic students, were excluded and were unable to provide any data.

The questionnaire was a secure, encrypted, web-based survey through Qualtrics (QLite version), and participants did not have unique identifiers. If participants desired the token compensation, they chose to supply their name and email address so this could be provided. I managed the surveying, provided survey links to the colleges, and delinked identifiers from questionnaire data (for those students who sought the $2 credit--no others have identifiers). Data were analyzed with confidentiality–I delinked any supplied identifiers prior to analysis. Participants who completed the questionnaire saw a thank you screen and had the option to receive a $2 Amazon credit, which required them to allow me to transmit their name and email address (not their responses) to as a CSV file to Giftbit, a company that provides these gifts in scale. Giftbit uses enterprise level security to protect confidentiality–but participants had to voluntarily permit their name and email to be transmitted to Giftbit to receive the credit. I transmitted this information without viewing it linked to the data, and I did not retain this file when the transmission was complete. The CSV file is retained securely by Giftbit but not used by that company for any further purpose. Credits not claimed within 3 months expire. Giftbit sends a reminder email to participants to claim the credits.

Exiting the study. Participants could exit at any time without adverse consequence. There was no debriefing as none was needed. Participants received my contact information to inquire about summary findings or to ask questions.

Instrumentation and Operationalization of Constructs

There was no standard questionnaire for MRSA risk factors (Macario et al., 2010). The content for this questionnaire (Appendix A) was influenced by the literature (see Tables 4 and 5 in Chapter 2) and stemmed from Bearman et al. (2010; Appendix F), Evans & Breshears (2007; Appendix H), and the CDC (2013b; Appendix G). Many questions were in yes/no format and inquired about the past 12 months or the 12 months prior to self-reported diagnosis of MRSA SSTI. These improve recall and facilitate reporting of sensitive behaviors (Blair et al., 1977; Brener et al., 2003; Gmel & Lakosha, 2000; Tourangeau & Smith, 1998). The questionnaire did not produce a summary measure (and therefore was not tested for internal consistency by split half or other method; Cronbach, 1951); the questionnaire was essentially a brief list of independent items. Construct validity stemmed from basis in established MRSA risk factor questionnaires as noted and in the absence of an established tool (Macario et al., 2010).

The Bearman et al. (2010) questionnaire was piloted, but no reliability or validity data were available (G. M. L. Bearman, personal communication, May 29, 2014). The questionnaire was used within the Virginia Commonwealth University Health System for the study published by Bearman et al. in 2010. The questionnaire was reasonably applicable to the present study, having been used to assess risk factors for CA-MRSA nasal carriage in a largely university student population (n=1000). I studied MRSA SSTI rather than carriage in an entirely student population. Permission was received from the author to use the questionnaire or questions therefrom (G. M. L. Bearman, personal communication, May 29, 2014; Appendix F).

The Evans & Breshears (2007) questionnaire was assessed for face validity with content experts (M. W. Evans, personal communication, July 27, 2014), but no reliability of validity data were available. The questionnaire was used in a study of chiropractic student hygiene attitudes and practices. The questionnaire was directly applicable to my study–as the questions assessed frequency of hand and table hygiene. Permission was received from the publisher to reprint and adapt the questionnaire (see Appendix H).

The healthcare exposure questions came from the case report (CDC, 2013b) and stemmed from literature regarding the epidemiologic definition of HA-MRSA (CDC, 2010; Klevens et al., 2006; McDougal et al., 2010). The ABCs group developed the questionnaire based on their case definition of HA-MRSA (CDC, 2012). The definition of healthcare exposures in my study was essentially identical to their definition of HA-MRSA : “1) a history of hospitalization, surgery, dialysis, or residence in a long term care facility in the previous year, or 2) the presence of a central vascular catheter (CVC) within 2 days" (CDC, 2012, p.1). My study also included prior MRSA infection (CDC, 2010, 2012; Klevens et al., 2006; McDougal et al., 2010). Permission was not needed to use and adapt questions from the CDC's case reporting form for noncommercial purposes as it was produced by a government agency for reporting purposes (Appendix G). The earlier work by Klevens et al. (2006) and McDougal et al. (2010) relative to use of these definitions was conducted using ABCs surveillance samples. In 2012 the ABCs surveillance area covered 26 areas in the United States and represented a population of 19,635,461 people (CDC, 2012).

Reliability and validity measures did not exist for these factors, which are still not fully quantified or understood (Lowy, 2013)–in fact, Macario et al. (2010) indicated that prior investigations have used invalid questionnaires; reliability and validity are essentially not mentioned in CA-MRSA risk factor studies (Bearman et al., 2010; Miller, L. G. et al., 2012). Gorwitz et al. (2008) discussed statistical reliability but not questionnaire reliability or validity. My study used questions from previous studies with minimal modification for usefulness and clarity in order to assess variables of sharing items, jail, and intravenous drug use (Bearman et al., 2010); hygiene frequency (Evans & Breshears, 2007); and healthcare exposures (CDC, 2013b).

The questionnaire I used was a researcher instrument that lacked the same validity and reliability measures as other surveys in the field. This questionnaire had the advantage of asking questions in formats used in a study of 1000 (mostly) undergraduate students (Bearman et al., 2010). It had the advantage of asking questions in formats used in studies of chiropractic student hygiene (Evans & Breshears, 2007; Evans, Ramcharan, Ndetan et al., 2009)–and using questions from the CDC's active surveillance of a catchment area of 19,635,461 persons (CDC, 2013b). The questionnaire was sufficient for its very straightforward aim: to allow me to ascertain demographics, to find out–yes or no–if any exposures were present or occurred in a 12-month window, and to gather self-reported general frequency of hand and table hygiene.

Operationalization. Each variable is described here, including how each was measured, and an example item for each variable is provided.

Independent variables. The independent variables were stage of education (initiation of patient care or not), sharing of lotion, sharing of patient practice gowns, frequency of hand hygiene, and frequency of table hygiene.

For the stage of education (initiation of patient care or not) variable, students identified if they had commenced with patient care. This question was worded "Have you started treating patients in a college clinic? □Yes □No □Unsure." Odds ratios were calculated. Per the epidemiologic triad, this variable was a time variable.

The question regarding the sharing of lotion was asked with minimal modification from Bearman et al. (2010). The question was "Do people share any of the following with you?" An option was "chiropractic or massage therapy lotion, lubricant, or emollient □Yes □No." Odds ratios were calculated. Per the epidemiologic triad, this variable was a person variable.

The question regarding the sharing of patient gowns was asked with minimal modification from Bearman et al. (2010). The question was "Do people share any of the following with you?" An option was "patient practice gowns □Yes □No." Odds ratios were calculated. Per the epidemiologic triad, this variable was a person variable.

The question regarding frequency of hand hygiene was asked with minimal modification from Evans and Breshears (2007). The question was "Regarding your treatment or examination of fellow students or patients, which most appropriately describes your hand sanitizing practices? □After contact with students/patients, I never sanitize my hands □After contact with students/patients, I rarely sanitize my hands □After contact with students/patients, I occasionally sanitize my hands □After contact with students/patients, I frequently sanitize my hands □After contact with students/patients, I always sanitize my hands." Frequent sanitizers combined *frequently* and *always.* Odds ratios were calculated. Per the epidemiologic triad, frequency of hand hygiene was a person variable.

The question regarding frequency of table hygiene was asked directly from Evans and Breshears (2007). The question was "When using treatment tables in palpation labs or clinics which best describes your current efforts to sanitize the table surface in addition to changing the face-paper? □I never wipe the table with a sanitizing agent □I rarely wipe the table with something to sanitize its surface □I occasionally wipe the table with something to sanitize its surface □I frequently wipe the table with something to sanitize its surface □I always wipe the table with something to sanitize its surface." Frequent sanitizers combined *frequently* and *always*. Odds ratios were calculated. Per the epidemiologic triad, frequency of table hygiene was a person variable.

Dependent variable. The dependent variable was self-reported, postmatriculation diagnosis of MRSA-SSTI. Participants identified if they experienced this at least once. Questions regarding MRSA SSTI will be preceded with the reminder: “MRSA refers to antibiotic resistant staph or ‘mersa.’” This question asked “Did you ever have a medically diagnosed MRSA infection of the skin or of the tissues under the skin **after** starting to attend chiropractic college?” This was a categorical variable.

Control variables. These were assessed by stratification for interaction effects with the other variables. I included the variables of age, gender, race, nation of origin, campus, healthcare exposures, incarceration, military history, and use of intravenous drugs as control variables consistent with the epidemiologic triad. Each has been previously studied (see Chapter 2), except chiropractic college campus–appropriately included in this study as a place variable. Each was collected with the online survey.

The question regarding age was asked directly from Bearman et al. (2010): “How old are you? ___ Years.” Mean age was calculated from survey responses.

The question regarding gender was asked directly from Bearman et al. (2010): “What is your gender? □Male □Female.”

The question regarding race was asked directly from Bearman et al. (2010): “Which of the following best describes your race? □American Indian/Alaskan Native, □Asian, □Black or African American, □Hispanic or Latino Origin, □Native Hawaiian or Pacific Islander, □White or Caucasian, □Other __________.”

The question regarding nation of origin was asked directly from Bearman et al. (2010): “What country were you born in? □United States □Other.”

The question regarding campus location attended was asked: “Which chiropractic college do you attend?” and the survey response options included all U. S. chiropractic colleges to conceal participating colleges by not only listing participants.

I adapted healthcare exposure questions from the case report (CDC, 2013b) and these stemmed from the literature (CDC, 2010; Klevens et al., 2006; McDougal et al., 2010). Through questionnaire logic I posed the question slightly differently to different groups: those who indicated prechiropractic MRSA SSTI, those who indicated postmatriculation MRSA SSTI, and those who indicated never having MRSA SSTI. A sample item was: “You indicated that you had a diagnosed MRSA infection of the skin or tissue under the skin **before** starting chiropractic college. If you have had more than one of these MRSA infections in your life **before** starting chiropractic college, answer this question relative to the first. Which of the following apply to **this** MRSA infection (check all that apply): □ surgery within 12 months before infection □ dialysis within 12 months before infection □ hospitalization within 12 months before infection □ residence in a long-term care facility within 12 months before infection □ central venous catheter within 12 months before infection □ none of these/unsure.” The questions were similar for the other 2 groups.

The question regarding jail was asked similarly to Bearman et al. (2010): “Have you been in correctional facilities or jail? □Yes □No.”

The question regarding military history was asked in this manner: “Have you ever served in the military? □Yes □No □Unsure.”

The question regarding injection drug use was asked similarly to Bearman et al. (2010): “Have you ever injected drugs into your veins or under your skin? □Yes □No.”

Data Analysis Plan

Data were analyzed using Qualtrics (QLite version), Stata (Small Stata version 14.1) IBM SPSS Statistics Premium (version 21.0.0.0), and Microsoft Excel (version 14.5.8). Question and page logic, skip patterns, and data validation supported complete and accurate data collection. Data were exported directly from Qualtrics to avoid transcription errors. Incomplete surveys were not used–each question required answering to advance and complete the survey.

RQ1. Is frequency of hand hygiene (frequent vs. infrequent) between practice partners and patients significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI?

***H_0*1.** Frequency of hand hygiene (frequent vs. infrequent) between practice partners and patients is not significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

***H_a*1.** Frequency of hand hygiene (frequent vs. infrequent) between practice partners and patients is significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

RQ2. Is frequency of treatment table hygiene (frequent vs. infrequent) between practice partners significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI?

***H*₀2.** Frequency of treatment table hygiene (frequent vs. infrequent) between practice partners is not significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

H_a2. Frequency of treatment table hygiene (frequent vs. infrequent) between practice partners is significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

RQ3. Is sharing of lotions, emollients, and lubricants significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI?

$H_0$3. Sharing lotions, emollients, and lubricants is not significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

H_a3. Sharing lotions, emollients, and lubricants is significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

RQ4. Is sharing of patient practice gowns significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI?

***H_0*4.** Sharing of patient practice gowns is not significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

***H_a*4.** Sharing of patient practice gowns is significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

RQ5. Is stage of chiropractic education (institution of patient care or not) significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI?

***H_0*5.** Stage of chiropractic education (institution of patient care or not) is not significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

***H_a*5**. Stage of chiropractic education (institution of patient care or not) is significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

Independent variables were frequency of hand (RQ1) and table hygiene (RQ2), sharing of lotions (RQ3) and patient practice gowns (RQ4), and stage of education. Each was a dichotomous, categorical variable, as was the dependent variable of MRSA SSTI. Age, race, gender, nation of origin, campus, healthcare exposures, military service, jail, and intravenous drug use were control variables. I assessed the relationship between variables by χ^2 or Fisher's exact test. Odds ratios and 95% confidence intervals were calculated, with $p < 0.05$ and two-tailed tests. I used the Mantel-Haenszel summary measure of effect to assess confounding and reported adjusted odds ratios, assessed effect modifiers and reported stratum specific estimators by interaction term, and constructed a final logistic regression model of self-reported MRSA SSTI to assess the strength of the relationship between variables, controlling for confounders. I included any variable associated with self-reported SSTI at the univariate level ($p < 0.20$) in the main regression model.

Threats to Validity

External validity concerns application beyond the study. The results apply specifically to chiropractic students attending nine participating campuses. I conducted the study with 9 of 18 U.S. chiropractic college campuses (and excluded my employer). The results of my study apply to a lesser extent to the ≈9,863 chiropractic students attending all U.S. chiropractic colleges (McCoy Press, 2013). The intended sample of n = 370 students represented ≈3.8% of all U.S. chiropractic students. For the results to apply to other North American and international chiropractic students or to students of other health professions–a larger sampling frame and other changes would be required. My study may reveal the usefulness of a larger study. Some other threats to external validity do not apply to this study because of the study design: testing reactivity, reactive effects of experimental arrangements, multiple-treatment interference, and interaction effects of selection and experimental variables (Creswell, 2009; Porta, 2008).

Internal validity concerns bias and the strength of inference. This study is correlational. I assessed confounding and effect modifiers as described in this chapter. Threats related to passing time or retesting are not concerns as I used a single questionnaire in cross-sectional format in close temporal proximity in this study; these threats include: history, maturation, repeated testing, regression to the mean, diffusion, and experimental mortality. Statistical regression was not a threat; participants were not selected based on baseline score; rather, all students on nine campuses were invited. Selection bias was a threat; it was important that there were not significant differences between participating and nonparticipating students or colleges (Creswell, 2009; Porta, 2008). I described methods to control and assess for these within.

To enhance construct validity I based the survey in the literature (see Tables 4 and 5 in Chapter 2), as there was no standard questionnaire (Macario et al., 2010). The exposure questions I used came directly from established sources (Bearman et al., 2010; CDC, 2013b; Evans, & Breshears, 2007) with the exception of the questions on campus attended and military service, both influenced by Bearman et al. (2010). Statistical conclusion validity was strengthened through the methodology described in this chapter. For example, I assessed statistical interaction with stratification and used the Mantel-Haenszel summary measure to assess for confounding. I addressed the threat of low statistical power by inviting a census of all students attending nine chiropractic college campuses and intending to enroll 370 participants–a number adequate per power calculations as described. For assessed risk factors with few respondents I used Fisher's exact test. I used an alpha of 0.05 and $p < 0.05$ with two-tailed tests to assess for association as described, based on previously published work.

Ethical Procedures

Ethical treatment of human participants is a fundamental concern. In this section I review procedures in place to protect human research participants in this study.

Access to Participants

IRB approval was obtained from Walden University (as the IRB of record), as the study was performed at multiple chiropractic colleges throughout the United States. Walden University's approval number for this study is 07-21-15-0044721 and it expires on July 20, 2016. Additionally, administrative and/or IRB approval was received from the participating chiropractic colleges (details are provided in Appendix I). These approvals constituted the agreement to have access to human research participants.

Treatment of Participants

The colleges distributed IRB-approved recruitment materials by email. When students are involved there is a concern of coercion. Recruiting materials made it clear that participation was completely voluntary, with no penalty or repercussion of any form for nonparticipation. Chiropractic students attending my employing chiropractic college could not participate. Similarly, no benefit was received by volunteers except whatever general benefit was derived by humankind secondary to the performance of the research. Chiropractic students who agreed to participate and complete the survey had the opportunity to receive token compensation ($2 Amazon credit) if they chose to permit their name and email address to be provided to a secure service (Giftbit) that managed the credit. This token compensation was sufficiently small to minimize concerns of coercion–94.2% of 610 respondents from a random sample drawn from the Public Responsibility in Medicine and Research database (an IRB and research ethics group) felt it was acceptable to offer compensation to healthy volunteers for these reasons (Largent, Grady, Miller, & Wertheimer, 2012).

All were free to reject participation or withdraw at any time without repercussion. I made no attempt to dissuade those who wished to withdraw. There were no negative consequences for nonparticipation. Conversely, I anticipated and found no adverse events of consequence for participation. The main possible adverse event of minimal concern and likelihood was distress caused by the risk factor questionnaire. Some of the questions were of a personal nature, such as might be encountered in a routine medical history, and mild embarrassment or distress was theoretically possible. I assured students that their responses were confidential, told them that they were free to withdraw for any reason, and reminded them of access to counseling services available at the colleges.

Treatment of Data

Data were always confidential for students who supplied their name and email address for the $2 credit; data for all other participants were anonymous. I separated identifiers before data were accessed for analysis and retained no identifying information. Data were only accessible by me, and I was identified to participants in the Informed Consent. Confidentiality was preserved through destruction of individually identifying features as soon as possible and care in collection and storage of data. No data category with less than five responses is reported individually. De-identified data will be maintained for 5 years and then destroyed; paper will be shredded and electronic data erased.

Participants completing the survey were offered the opportunity to receive a $2 Amazon credit. If they elected to receive this token compensation, they authorized transmission of their name and email address–not responses–by me to a third party

(Giftbit) that uses enterprise level security to protect their information. Participants received the credit in automated fashion and I did not access the list of participant names in a way that linked them to the responses. Participants did not have to elect to receive the token credit and could still participate.

Electronic data were stored in password-protected files on password-protected computers with secure, remote back-up. No paper files were generated for storage. Identifiable information was not retained beyond data collection unless authorized to transmit to Giftbit. I delinked this information before submission to Giftbit and did not include responses. De-identified/aggregate data may be distributed and published to further scientific knowledge, but no identifiable data will ever be disseminated.

Summary

The present study was quantitative and cross-sectional, and I collected data for it through surveys. I used univariate analysis and logistic regression to evaluate the association of infection control and other factors and self-reported diagnoses of MRSA SSTI, and I performed tests for interaction and confounding. In this chapter I reviewed the research design and methodology related to the inquiry. I reviewed threats to validity as well as ethical procedures. In Chapters 4 and 5 I provide results and conclusions.

Chapter 4: Results

My purpose with this quantitative, cross-sectional study was to obtain the first correlation of infection control hygiene behaviors (frequency of hand and table hygiene, sharing of lotions/lubricants, and sharing of patient practice gowns) and stage of education with self-reported MRSA SSTI in chiropractic students. I sought to address the following research questions and hypotheses:

RQ1. Is frequency of hand hygiene (frequent vs. infrequent) between practice partners and patients significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI?

$H_0$1. Frequency of hand hygiene (frequent vs. infrequent) between practice partners and patients is not significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

H_a1. Frequency of hand hygiene (frequent vs. infrequent) between practice partners and patients is significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

RQ2. Is frequency of treatment table hygiene (frequent vs. infrequent) between practice partners significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI?

$H_0$2. Frequency of treatment table hygiene (frequent vs. infrequent) between practice partners is not significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

H_a2. Frequency of treatment table hygiene (frequent vs. infrequent) between practice partners is significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

RQ3. Is sharing of lotions, emollients, and lubricants significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI?

$H_0$3. Sharing lotions, emollients, and lubricants is not significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

H_a3. Sharing lotions, emollients, and lubricants is significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

RQ4. Is sharing of patient practice gowns significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI?

$H_0$4. Sharing of patient practice gowns is not significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

***H*a4.** Sharing of patient practice gowns is significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

RQ5. Is stage of chiropractic education (institution of patient care or not) significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI?

H*0*5.** Stage of chiropractic education (institution of patient care or not) is not significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

***H*a5.** Stage of chiropractic education (institution of patient care or not) is significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI.

In this chapter, I review data collection and results. After the summary, I offer discussion, conclusion, and recommendations in Chapter 5.

Data Collection

In this section, I discuss recruitment and response, discrepancies from planned methods, sample demographics and representativeness, and univariate analysis and covariates.

Recruitment and Response

As reported in Chapter 3, I sought to obtain complete surveys from 370 unique respondents to have hypothetical power to answer the five research questions. Additionally, per the original study design, I indicated that unless three colleges agreed to participate, I would not conduct the study. This was to help mask the identity of participating colleges. Ultimately, the study succeeded in obtaining complete questionnaires from 312 unique participants attending nine U.S. chiropractic college campuses. The participating college campuses represented half of all U.S. chiropractic campuses as well as ≈40% of U.S. chiropractic college students. Respondents represented ≈7.9% of all chiropractic students at the nine participating campuses.

As additional detail: There are ≈2,500 chiropractic college students graduating per year in the United States, as previously described. The nine participating campuses in my study graduated ≈1,000 students in the 2013/2014 school year, the last year for which IPEDs data were available (U.S. Department of Education National Center for Education Statistics, n.d.). The precise number of graduates at these nine participating campuses is not described--though I know the number--to prevent indirect disclosure of which campuses participated in the study; those determined to reverse engineer the data using the graduation statistics might be able to surmise which schools participated or likely participated if I provided this data, and participating campuses insisted on being masked. However, these nine campuses graduate ≈1,000 of the ≈2,500 annual chiropractic college graduates, or ≈40% of all the graduates.

According to IPEDS data, 9,863 chiropractic students were enrolled in U.S. colleges in 2013, (McCoy Press, 2013). Therefore, recruitment emails were sent to ≈3,945 (≈40% x 9,863) chiropractic students. Completed surveys were received from 312 students. The overall response rate at participating colleges was 312 / ≈3,945, or ≈7.9%.

Data collection occurred from August 17, 2015 to October 26, 2015, a period of approximately two months. This data collection period spanned the time it took for me to receive IRB and/or administrative approval at each college and administer the survey at the campuses–after receiving IRB approval from Walden University. The collection period at any campus varied based on when approval was received and the colleges initiated the email surveys. Data collection was not initiated at any campus until I received approval from at least three chiropractic colleges. The first campus administered a survey on August 17, 2015. The last campus sent out the last survey on October 23, 2015, and data collection closed on October 26, 2015. Table 8 provides the dates that surveys were distributed to students and the number of campuses that received surveys that date, and Figure 1 demonstrates the daily and cumulative number of completed surveys received through the study period. Figure 2 demonstrates participant flow and response/completion rate through the study period.

Table 8

Dates Surveys Distributed and Number of Campuses Distributing Surveys

Date	Campuses
8/17/15	1
8/20/15	1
8/24/15	1
8/26/15	2
8/28/15	1
8/30/15	1
9/1/15	2
9/3/15	1
9/8/15	1
9/15/15	1
9/17/15	1
9/23/15	1
9/25/15	2
9/30/15	4
10/4/15	2
10/8/15	1
10/15/15	1
10/16/15	1
10/19/15	1
10/23/15	1

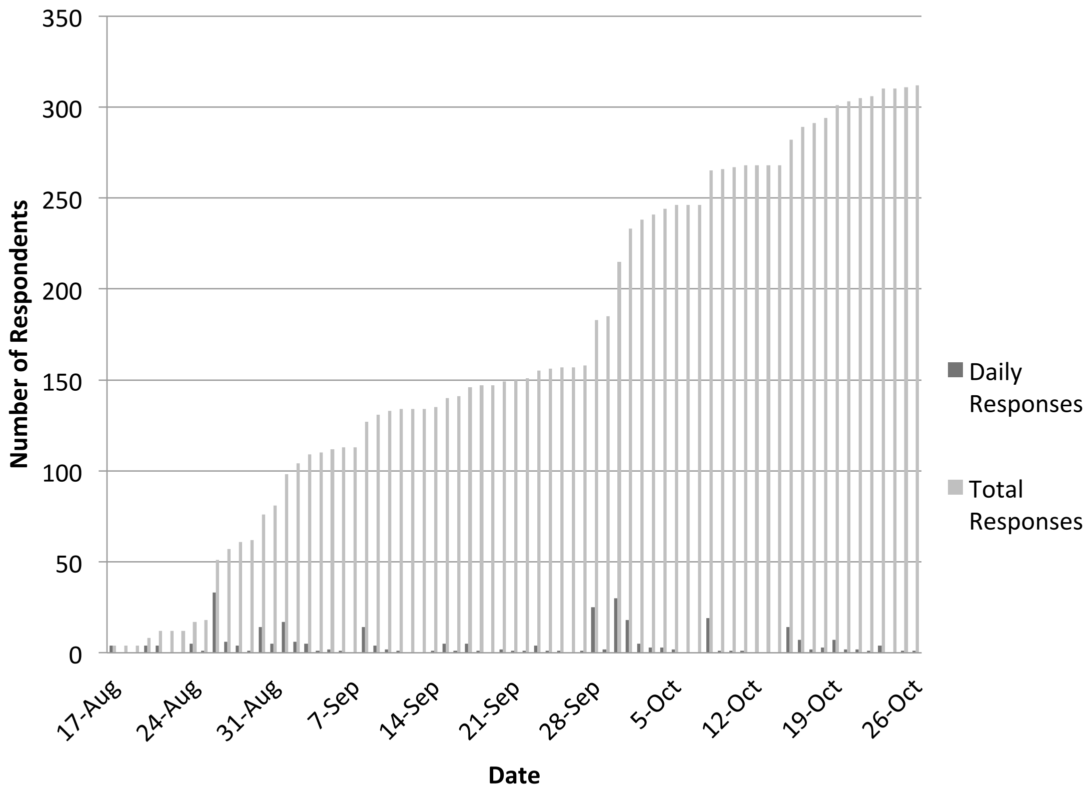

Figure 1. Daily and cumulative survey completions for participants.

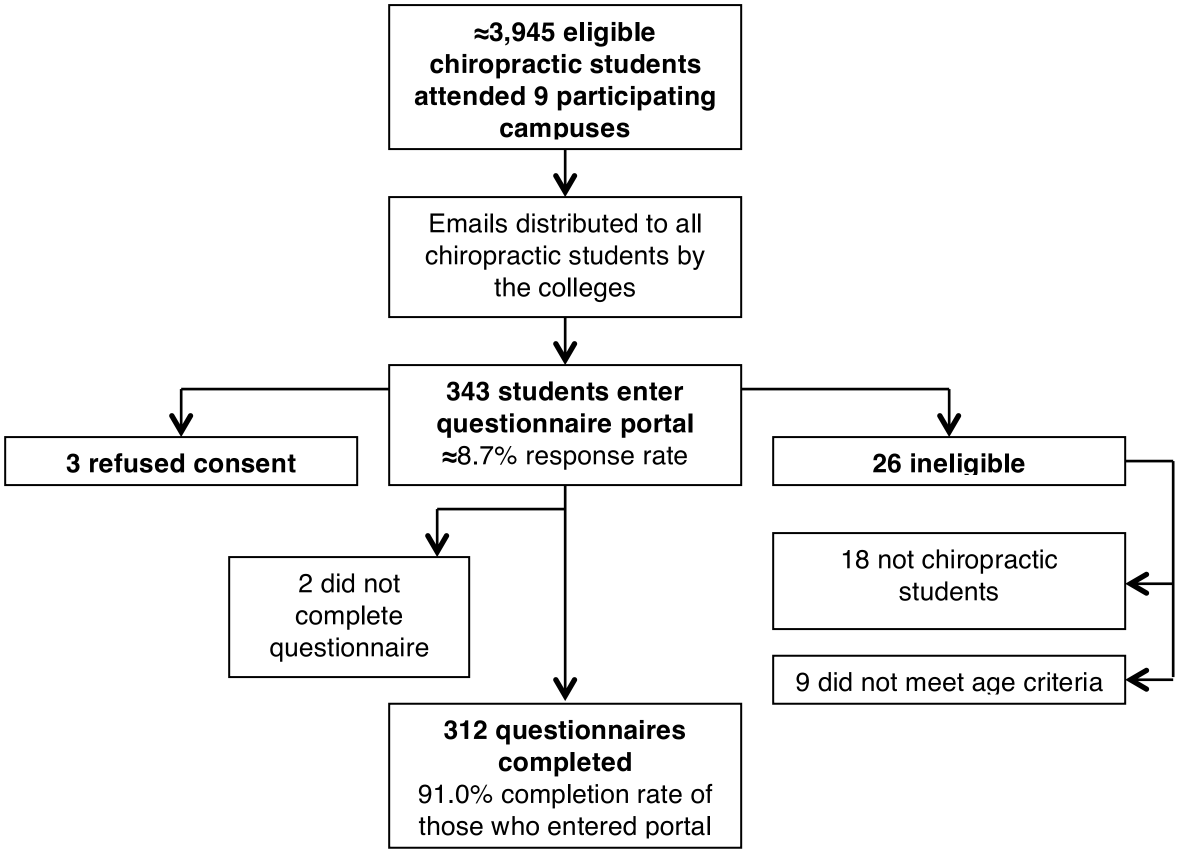

Figure 2. Participant flow and response/completion rate through recruitment and survey process at nine U.S. chiropractic college campuses. Excluded participants appear to exceed 26; participants could select multiple exclusion criteria.

Discrepancies in Collection From Planned Methods

There was no discrepancy in the actual collection method from what was planned and described in Chapter 3. Students received links to the Qualtrics (QLite version) surveys and took the surveys by that software. There were small variations consistent with the methods in the timeline from campus to campus; campuses had to send the surveys at least four days apart–some chose to send them once a week, some sent them every four days, some only sent them when reminded–but in no case were they farther than eight days apart. One campus sent a single survey about four hours early. A change in protocol requested by one of the participating colleges and approved by Walden's IRB meant that students verified the three inclusion/exclusion criteria an additional time when entering the questionnaire. This may have led to some inadvertent selection of exclusion criteria by some participants–essentially providing an extra opportunity for incorrect data entry on the student participants' parts. However, overall, 91.0% of students who entered the Qualtrics portal (QLite version) ultimately were both included and elected to complete the entire questionnaire. As noted, this can be seen in Figure 2.

Sample Demographics and Representativeness

I report baseline demographics of the sample in Table 9. In that table, I report values that are lower than 5 as "#" to be consistent with IRB approval, which required reporting no variable with fewer than five responses to help protect confidentiality. I compare baseline characteristics of the sample to publicly available demographics of U.S. chiropractic students in Table 10. As seen in Table 10, chiropractic student demographics from U.S. chiropractic colleges are only available from 3 to 6 campuses out of the 18 U.S. chiropractic college campuses, depending on the demographic, and these campuses are not necessarily any of the nine campuses that participated in the study. Therefore, no direct relationship between the study sample demographics at nine campuses and the demographics reported here from these 3 to 6 U.S. campuses can be drawn. Rather, the overall demographics from U.S. chiropractic students at these 3 to 6 campuses are provided as a measure of face external validity: The students at the nine study campuses and these 3 to 6 campuses with public data are indeed reasonably similar to one another–or are representative. However, because only means are available for the public data (rather than measures of variation), and because these campuses may or may not be the same campuses as those in the study (because participating campuses wish to stay obscured), direct comparison of means is not possible. Again, there appears to be a reasonable measure of face external validity. The populations are generally comparable, but an exact representation of the U.S. chiropractic student body is not available. The measures in Table 10 are the best available.

Table 9

Study Population Characteristics and Descriptive Statistics

Variable	Participants (*N* = 312), n (%)
Female	166 (53.2)
Age, years (mean ± SD)	28.04 ± 6.33
Race	
White/Caucasian	245 (78.5)
Hispanic or Latino Origin	22 (7.1)
Asian	19 (6.1)
Black or African American	11 (3.5)
Other	9 (2.9)
Country of Origin (Birth): United States	277 (88.8)
U.S. Chiropractic College Campus[a]	
Campus 1	64 (20.5)
Campus 2	51 (16.3)
Campus 3	50 (16.0)
Campus 4	41 (13.1)
Campus 5	36 (11.5)
Campus 6	32 (10.3)
Campus 7	23 (7.4)
Campus 8	10 (3.2)
Campus 9	5 (1.6)
Military service	12 (3.8)

(*table continues*)

Variable	Participants (*N* = 312), n (%)
Jail	20 (6.4)
Injected drugs	8 (2.6)
Postmatriculation MRSA SSTI	# (#)
Healthcare exposures[b]	
Prematriculation MRSA SSTI	10 (3.2)
Surgery[b]	13 (4.2)
Dialysis[b]	# (#)
Hospitalization[b]	10 (3.2)
Healthcare exposures[b] (Cont.)	
Central venous catheter[b]	# (#)
Residence in long term care[b]	# (#)
Initiation of patient care	89 (28.5)
Share lotion, lubricant, or emollient	56 (17.9)
Share patient gowns	36 (11.5)
Infrequent hand hygiene[c]	102 (32.7)
Infrequent table hygiene[c]	209 (67.0)

Note. Variables with less than 5 cases are reported as "#." SD = standard deviation; MRSA = methicillin resistant *Staphylococcus aureus;* SSTI = skin and soft tissue infection.
[a]The nine chiropractic campuses listed here are listed in order of the number of student responses received from each campus. The order does not represent any characteristic that might be used to identify any individual U.S. chiropractic campus. The response rates varied at the campuses, and no effort should be made to correlate the campuses listed here with any specific chiropractic college campus. [b]A combination of any exposures reported by the students, whether prior to prematriculation MRSA SSTI, prior to postmatriculation MRSA SSTI, or occurring in the past 12 months prior to answering the survey. [c]"Infrequent" combines the "never," "rarely," and "occasionally" responses in the questionnaire.

Table 10

Study Population Characteristics and Available U.S. Chiropractic Student Demographics

Characteristic	Study population mean (Nine campuses)	Weighted mean (# of campuses reporting characteristic)
Female (%)	53.2	39.3 (6[a])
Mean age (years)	28.04	26.7 (3[b])
Race: white/Caucasian (%)	78.5	67.7 (3[c])
National origin: United States (%)	88.8	91.4 (3[b])

Note. The six U.S. campuses reporting demographics are not necessarily those that participated in this study. These are the only campuses for which publicly available data on the chiropractic study body could be obtained. Not all campuses reported all characteristics. Some of the data are from college websites. Other data are from the U.S. Department of Education National Center for Education Statistics (*n.d.*), but data at this website drawn from Integrated Postsecondary Education Data System (IPEDS) includes all academic programs on the campuses. Therefore, only data from chiropractic-only institutions could be used–see note c below. The data in this table should not be used to draw direct conclusions about the representativeness of the sample relative to the sampling frame, as they do not necessarily represent the same college campuses. Rather, it is presented for face validity purposes; that is, the nine U.S. campuses in this study–and the 3 to 6 U.S. campuses represented in this table–are similar in composition.
[a]The six campuses with published, public, chiropractic student-only data are Life Chiropractic College West, Sherman College of Straight Chiropractic, and Texas Chiropractic College, with all data obtained through IPEDs at http://nces.ed.gov/collegenavigator/ per the U.S. Department of Education National Center for Education Statistics (*n.d.*), and Palmer-California, Palmer-Davenport, and Palmer-Florida, all obtained from Palmer's website at http://www.palmer.edu/about-us/accreditation/student-demographics/. As noted, these six campuses may or may not have participated in the study. [b]Age and national origin data are from the three Palmer campuses, obtained from Palmer's website at http://www.palmer.edu/about-us/accreditation/student-demographics/. As noted, Palmer's campuses may or may not have participated in the study. [c]Race data are from the three chiropractic-only campuses of Life Chiropractic College West, Sherman College of Straight Chiropractic, and Texas Chiropractic College, with all data obtained through IPEDs at http://nces.ed.gov/collegenavigator/ per the U.S. Department of Education National Center for Education Statistics (*n.d.*). As noted, these three campuses may or may not have participated in the study.

Univariate Analysis and Inclusion of Covariates

I display the Fisher's exact test p values (all tables had cells with less than five values) and odds ratios for each variable in the study in Table 11. As is evident in the table, only one of the control variables was significant in univariate analysis (Campus 6, $p = 0.010$), and only one other control variable was below the $p < 0.20$ cutoff for inclusion in regression analysis (MRSA SSTI prior to matriculation, $p = 0.063$). None of the other variables achieved significance in association or effect size in univariate analysis. I discuss this further in the Results section of this chapter as well as in Chapter 5.

Table 11

Univariate Association With Self-Reported, Postmatriculation, Diagnosed MRSA SSTI

Variable	Fisher's Exact Test *p*	*OR* (Exact)	95% *CI*
Gender (male)	0.500	0.000	[0.000, 2.180][a]
Age $\geq$ 29	1.000	1.952	[0.025, 153.983]
Nonwhite race	1.000	0.000	[0.000, 7.078][a]
Non-U.S. country of origin	1.000	1.000	[0.000, 15.511][a]
U.S. chiropractic college campus[b]			
Campus 1	1.000	0.000	[0.000, 7.515][a]
Campus 2	1.000	0.000	[0.000, 9.949][a]
Campus 3	1.000	0.000	[0.000, 10.190][a]
Campus 4	1.000	0.000	[0.000, 12.905][a]
Campus 5	1.000	0.000	[0.000, 15.015][a]
Campus 6	**0.010**	*	**[4.711, *]**[a]
Campus 7	1.000	0.000	[0.000, 24.953][a]
Campus 8	1.000	0.000	[0.000, 63.076][a]
Campus 9	1.000	0.000	[0.000, 139.631][a]
Military service	1.000	0.000	[0.000, 51.466][a]
Jail	1.000	0.000	[0.000, 29.162][a]
Injected drugs	1.000	0.000	[0.000,81.104][a]
Healthcare exposures[c]	1.000	0.000	[0.000, 29.162][a]
Prematriculation MRSA SSTI	0.063	33.444	[0.384, 2632.251]
Initiation of patient care	0.490	2.523	[0.032, 198.891]
Share lotion, lubricant, or emollient	0.327	4.636	[0.058, 365.303]
Share patient gowns	1.000	0.000	[0.000, 15.015][a]
Infrequent hand hygiene[d]	0.548	2.069	[0.026, 163.190]
Infrequent table hygiene[d]	0.552	0.490	[0.006, 38.866]

Note. *OR* = odds ratio. *CI* = confidence interval. MRSA = methicillin-resistant *Staphylococcus aureus*. SSTI = skin and soft tissue infection. Items in boldface are significant (p < 0.05) for Fisher's Exact Test. Fisher's Exact Test *p* value calculations performed in SPSS (version 21.0.0.0); all other values calculated using Stata (Small Stata version 14.1). Items with a "*" indicate that Stata did not return a value due to the limited number of cases. Fisher's Exact *p* values are 2-sided.
[a]Per Stata (Small Stata version 14.1), "Exact confidence intervals not possible with zero count cells." Cornfield values are reported rather than exact values here. [b]The nine chiropractic campuses listed here are listed in order of the number of student responses received from each campus. The order does not represent any characteristic that might identify any individual chiropractic campus. The response rates varied at the campuses, and no effort should be made to correlate the campuses listed here with any specific chiropractic college campus. [c]Any exposures, whether prior to prematriculation MRSA SSTI, prior to postmatriculation MRSA SSTI, or in the past 12 months. [d]"Infrequent" combines the "never," "rarely," and "occasionally" responses in the questionnaire.

I constructed two regression models with different inputs. The regression model I constructed using the five independent variables and any control variable significant at $p < 0.20$ per Fisher's exact test in univariate analysis therefore included attendance at Campus 6 ($p = 0.010$) and MRSA SSTI prior to matriculation ($p = 0.063$). All of the SSTI cases I detected by this study occurred at Campus 6. I will discuss this further in Chapter 5. The other regression model that I constructed included variables of interest from the strata specific analysis, which will be discussed in Results.

Results

Descriptive Statistics

Descriptive statistics are provided in Table 9 along with the baseline sample characteristics. There were fewer than five cases of postmatriculation MRSA SSTI detected, all reported from one participating chiropractic college campus (Campus 6). As noted, variables with fewer than five responses or cases will not be reported. I present no values that could specifically identify any participating chiropractic college or student. Descriptive statistics are in Table 9, and univariate analysis data are in Table 11.

Evaluation of Statistical Assumptions

I intended to use χ^2 for univariate analysis; Fisher's exact test was ultimately used in every case because the assumptions were filled for this test, but not for χ^2–specifically due to cell frequencies. The assumptions for Fisher's exact test were met: The variables were nominal, frequencies were below five in some of the cells, all cases were valid, all variables were dichotomous, and there were two groups in each variable (Lund Research Ltd., 2013b). Associations between variables can be tested by χ^2, but this test does not permit outcome prediction. Therefore, for the final predictive model, I used regression analyses to determine if it was possible to predict an outcome (dependent variable) based on any of the independent variables or covariates (Lund Research Ltd., 2013a, 2015b).

I calculated odds ratios because cases of postmatriculation MRSA SSTI were reported. However, the number of self-reported diagnoses of MRSA SSTI was smaller than expected based on the literature review–which will be further discussed. Because there were so few cases of postmatriculation MRSA SSTI detected, ORs for some strata could not be produced. I report individual strata that could be calculated in Table 12 and Appendix J, as well as crude odds ratios and weighted (Mantel-Haenszel) odds ratios where possible.

I constructed two regression models based on findings of univariate analysis and Mantel-Haenszel analysis. For the Mantel-Haenszel method, confounding and interaction/effect modification were determined as follows. First, I calculated crude odds ratios individually in Stata (Small Stata version 14.1) for the association between each independent variable from the five research questions and the dependent variable of MRSA SSTI. Then, I calculated stratum specific odds ratio estimates for every control variable as well as the weighted Mantel-Haenszel odds ratio. As noted, some odds ratios could not be reported due to the small number of cases detected. This process of producing strata specific estimated odds ratios produced fifty 2 x 2 x *k* tables, where *k* represents each added control variable, such as history of jail or military service. I report findings in Table 12 and Appendix J.

Table 12

MRSA SSTI After Chiropractic College Matriculation: Significant and Modified Effects

Variable	Covariable	Stratum	*OR*	95% *CI*	Applicable value
Hand hygiene			Crude: 2.069	[0.026, 163.190]	Fisher's $p = 0.548$
	Campus		**M-H combined: 0.875**[a]	[0.050, 15.326]	$\chi^2(1) = 0.01$; $p = 0.928$
		Campus 6	**Stratum specific: 0.875**[a]	[0.010, 73.532]	M-H weight: 0.500
		Others[b]	Stratum specific: *	*	M-H weight: 0.000
	Age >28		M-H combined: 1.961	[0.128, 29.868]	$\chi^2(1) = 0.25$; $p = 0.614$
		No	Stratum specific: *	[0.000, *]	M-H weight: 0.000
		Yes	**Stratum specific: 0.000**[a]	[0.000, *]	M-H weight: 0.349
	Gender (male)		**M-H combined: 1.780** [a]	[0.109, 28.977]	$\chi^2(1) = 0.17$; $p = 0.683$
		No	**Stratum specific: 1.780**[a]	[0.022, 141.000]	M-H weight: 0.355
		Yes	Stratum specific: *	*	M-H weight: 0.000
Table hygiene			Crude: 0.490	[0.006, 38.866]	Fisher's $p = 0.552$
	Campus		**M-H combined: 0.429**[a]	[0.024, 7.632]	$\chi^2(1) = 0.34$; $p = 0.561$
		Campus 6	**Stratum specific: 0.429**[a]	[0.005, 37.345]	M-H weight: 0.656
		Others[b]	Stratum specific: *	*	M-H weight: 0.000
	Age >28		M-H combined: 0.491	[0.027, 8.817]	$\chi^2(1) = 0.22$; $p = 0.636$
		No	Stratum specific: *	[0, *]	M-H weight: 0.000
		Yes	**Stratum specific: 0.000**[a]	[0.000, *]	M-H weight: 0.622
	Gender (male)		**M-H combined: 0.562**[a]	[0.035, 9.149]	$\chi^2(1) = 0.17$; $p = 0.683$
		No	**Stratum specific: 0.562**[a]	[0.007, 44.846]	M-H weight: 0.633
		Yes	Stratum specific: *	*	M-H weight: 0.000
	Prior MRSA SSTI		**M-H combined: 0.803**[a]	[0.031, 20.749]	$\chi^2(1) = 0.01$; $p = 0.907$
		No	Stratum specific: *	[0.000, *]	M-H weight: 0.000
		Yes	**Stratum specific: 0.000**[a]	[0,000, *]	M-H weight: 0.400
Share lotion			Crude: 4.636	[0.058, 365.303]	Fisher's $p = 0.327$
	Campus		**M-H combined: 29.000**[a]	[0.954, 881.396]	**$\chi^2(1) = 6.75$; $p = 0.009$**[c]
		Campus 6	**Stratum specific: 29.000**[a]	[0.185, 2347.222]	M-H weight: 0.031
		Others[b]	Stratum specific: *	*	M-H weight: 0.000

(*table continues*)

Variable	Covariable	Stratum	*OR*	95% *CI*	Applicable Statistic
Share lotion (cont.)	Prior MRSA SSTI		**M-H combined: 3.989[a]**	[0.213, 74.818]	$\chi^2(1) = 0.78$; $p = 0.379$
		No	**Stratum specific: 0.000[a]**	[0.000, *]	M-H weight: 0.175
		Yes	Stratum specific: *	[0.000, *]	M-H weight: 0.000
Stage (patient care)			Crude: 2.523	[0.032, 198.891]	Fisher's $p = 0.490$
	Campus		**M-H combined: 1.500[a]**	[0.085, 26.361]	χ^2 (1) = 0.08; $p = 0.783$
		Campus 6	**Stratum specific: 1.500[a]**	[0.018, 124.185]	M-H weight: 0.375
		Others[b]	Stratum specific: *	*	M-H weight: 0.00
	Age >28		M-H combined: 2.694	[0.110, 66.282]	χ^2 (1) = 0.32; $p = 0.573$
		No	**Stratum specific: 0.000[a]**	[0.000, *]	M-H weight: 0.214
		Yes	Stratum specific: *	[0.000, *]	M-H weight: 0.000
	Prior MRSA SSTI		M-H combined: 2.458	[0.161, 37. 606]	χ^2 (1) = 0.42; $p = 0.519$
		No	**Stratum specific: 0.000[a]**	[0.000, *]	M-H weight: 0.285
		Yes	Stratum specific: *	[0.000, *]	M-H weight: 0.000

Note. OR = odds ratio. *CI* = confidence interval. MRSA = methicillin-resistant *Staphylococcus aureus*. SSTI = skin and soft tissue infection. M-H = Mantel-Haenszel. Calculations performed using Stata (Small Stata version 14.1). Items in boldface have a pooled Mantel-Haenszel odds ratio or stratum specific odds ratio that varies more than 10% from the crude odds ratio (indicating potential confounding), or a value with a significant χ^2 ($p < 0.05$) indicating potential effect modification. Items with a "*" indicate that Stata did not return a value due to the limited number of cases. Fisher's Exact *p* values are 2-sided, calculated with SPSS (version 21.0.0.0). All 2 x 2 x *k* tables are in Appendix J.
[a]Potential confounding is present; a calculated stratum odds ratio varies by more than 10% from the crude odds ratio. Both strata odds ratios would need to be similar to each other - and both vary from the crude odds ratio by 10% - for true confounding. However, because of the small number of cases detected, one stratum did not return a stratum specific odds ratio. Therefore, this represents potential confounding, as at least one stratum odds ratio varied by more than 10% from the crude OR. The pooled Mantel-Haenszel estimate should be used. [b]Others are campuses 1-5 and 7-9, which each had the same values individually. The value listed here is the individual value produced for each campus separately. [c]There was interaction between campus, sharing lotion, and postmatriculation MRSA SSTI, with the Mantel-Haenszel pooled estimate varying significantly from unity. The pooled M-H value should not be used where potential effect modification is present.

I considered confounding in strata specific analysis to have occurred when strata measures were similar to each other, but varied more than 10% from the crude estimate (Boston University School of Public Health, n.d.). However, this was termed *potential confounding* in this study, because although one strata may have varied by 10% from the crude estimate, the other strata was not reported by the software due to the small number of cases detected. Because of this, it could not be determined if both strata varied by more than 10%. Therefore, I reported variance of more than 10% from the crude estimate by a single, calculated strata as *potential confounding*. While Mantel-Haenszel adjusted odds ratios are reported for all of the strata specific analyses in Table 12, these weighted estimates are required where confounding is detected–otherwise, where all strata estimates and the weighted Mantel-Haenszel values are similar to the crude estimate, the strata specific estimates are not individually necessary, as that would indicate confounding and effect modification are not present (Boston University School of Public Health, n.d.).

Effect modification was determined to have occurred when the odds ratios of the stratum specific estimates were significantly different from each other per χ^2. When this occurs, the pooled Mantel-Haenszel estimated odds ratio and crude odds ratio estimate should not be used, as the strata are significantly different from one another - and pooling and weighting would not be appropriate (Boston University School of Public Health, n.d.). However, this was termed *potential effect modification* in this study, because the software did not report both strata due to the small number of cases detected. I generically list the pooled estimates for all 2 x 2 x *k* analyses in Table 12, but as noted, the pooled estimate should not be used where potential effect modification was detected. In this study, that occurred for one stratum/variable combination (MRSA SSTI x Campus x sharing lotion), which will be discussed.

For the regression analysis, I used binomial logistic regression because the outcome variable was dichotomous, as were all the variables (Lund Research Ltd., 2013a). If the dependent variable had been continuous, linear regression could have been used (Lund Research Ltd., 2013d). Log linear analysis could have been used in this study as all variables were categorical, but was not used because the assumptions for that test were not met, particularly the assumptions regarding having cases be five times the number of cells and all cells for two-way interactions being greater than five (Lund Research Ltd, 2013c), which was not possible with this data. For binomial logistic regression, which was used in this study, assumptions require that variables can be continuous or categorical (all were categorical in this study), and a dichotomous dependent variable is required (and met in this study). Other assumptions for regression include 15 cases per independent variable (met, as this would require at least 70 cases and the study obtained 312 responses), independence of cases (met with 312 independent student responses), no significant outliers (challenging in this study; with so few instances of MRSA SSTI reported, the detected cases could actually be considered outliers–however, this was otherwise met per SPSS regression output of studentized residuals), and no multicollinearity (met, described next) (Lund Research Ltd., 2013a).

The multicollinearity assumption is met; I ran a linear regression model to produce variance inflation factors (VIFs) to assess for collinearity of multiple variables in the study–collinearity can inflate variance (Penn State Eberly College of Science, 2015). One linear regression model I ran to produce the VIFs included the dependent variable, the five independent variables, and the two control variables significant in univariate analysis at $p < 0.020$. None of these had a VIF > 4.00, an accepted threshold (Penn State Eberly College of Science, 2015); indeed, none of these had a VIF greater than 1.166, indicating no important multicollinearity. I report those values in Table 13 in addition to the tolerance values, which also indicate no multicollinearity as they each approach 1.0.

Additionally, a separate linear regression model was run with all the independent variables, dependent variable, and control variables in the study. None of these had a VIF greater than 1.645. The assumption of no multicollinearity was met (Lund Research Ltd., 2013a; Penn State Eberly College of Science, 2015). Last, as there were no continuous independent variables in analysis, there was no need to assess for the relationship with the logit transformation of the dependent variable (Lund Research Ltd., 2013a).

Table 13

Collinearity Statistics

Model	Tolerance	Variance inflation factor
Campus 6	0.900	1.112
Initiation of patient care	0.944	1.060
Share lotion, lubricant, or emollient	0.858	1.166
Share patient gowns	0.898	1.114
Infrequent hand hygiene[e]	0.888	1.126
Infrequent table hygiene[e]	0.900	1.111

Note. Values calculated in SPSS (version 21.0.0.0)

Statistical Analysis

In this section, I report statistical analyses by research question. Exact statistics, probabilities, 95% confidence intervals, and effect sizes are reported as appropriate.

RQ1. Is frequency of hand hygiene (frequent vs. infrequent) between practice partners and patients significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI?

In Chapter 3, I assumed that 22% of chiropractic students would report utilizing infrequent hand hygiene, based on prior research. In this study, 102/312 students, or 32.7%, reported utilizing infrequent hand hygiene, a somewhat larger number than expected. As noted, fewer than five cases of self-reported, postmatriculation MRSA SSTI were detected among respondents.

In Table 11 I reported the crude odds ratio for univariate analysis of the association between each variable and MRSA SSTI. In this case, Fisher's exact test for association between infrequent hand hygiene and self-reported MRSA SSTI was used as cells had frequencies below five. There was no statistically significant association between infrequent hand hygiene and MRSA SSTI after starting chiropractic college, crude OR = 2.069, 95% CI [0.026, 163.190], p = 0.548. The Mantel-Haenszel method was used to assess for stratum specific effects. There were ten 2 x 2 x k tables for this research question, the results of which I provide in Appendix J. Strata with potential confounding or effect modification for any of the research questions are noted in Table 12. In the case of infrequent hand hygiene, there was potential confounding regarding the following strata: campus, age, and gender. For these variables, see Table 12 for crude odds ratios, Mantel-Haenszel weighted estimated odds ratios, stratum specific estimated odds ratios, and χ^2 statistics regarding the Mantel-Haenszel odds ratio. None of these were significant. The null hypothesis for RQ1 is not rejected. There is no association between infrequent hand hygiene and self-reported postmatriculation MRSA SSTI in this sample of students from nine chiropractic college campuses. I will report the results of the regression analyses after discussion of RQ5.

RQ2. Is frequency of treatment table hygiene (frequent vs. infrequent) between practice partners significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI?

In Chapter 3, I assumed that 71% of chiropractic students would report utilizing infrequent table hygiene, based on prior research. In this study, 209/312 students, or 67.0%, reported utilizing infrequent table hygiene, essentially as expected.

Fisher's exact test for association between infrequent table hygiene and self-reported MRSA SSTI was used. There was no statistically significant association between infrequent table hygiene and MRSA SSTI after starting chiropractic college, crude OR = 0.490, 95% CI [0.006, 38.866], p = 0.552. The Mantel-Haenszel method was used to assess for stratum specific effects. There were ten 2 x 2 x k tables for this research question, the results of which are provided in Appendix J. Strata with potential confounding or effect modification can be seen in Table 12. As was the case with infrequent hand hygiene, there is also potential confounding regarding the following strata: campus, age, and gender–in addition to the control variable of prior MRSA SSTI. For these variables, see Table 12 for crude odds ratios, Mantel-Haenszel weighted estimated ORs, stratum specific estimated odds ratios, and χ^2 statistics regarding the Mantel-Haenszel odds ratio. None of these were significant. The null hypothesis for RQ2 is not rejected. There is no association between infrequent table hygiene and self-reported postmatriculation MRSA SSTI in this sample of students from nine chiropractic college campuses.

RQ3. Is sharing of lotions, emollients, and lubricants significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI?

In Chapter 3, I assumed that 42.4% of chiropractic students would report sharing lotions, emollients, and lubricants, based on prior research. In this study, 102/312 students, or 32.7%, reported sharing these lotions, somewhat fewer than expected.

Fisher's exact test for association between sharing lotions and self-reported MRSA SSTI was used. There was no statistically significant association between sharing lotions and MRSA SSTI after starting chiropractic college, crude *OR* = 4.636, 95% *CI* [0.058, 365.303], $p = 0.327$. The Mantel-Haenszel method was used to assess for stratum specific effects. There were ten 2 x 2 x *k* tables for this research question, the results of which are provided in Appendix J. Strata with potential confounding or effect modification are provided in Table 12. As was the case with infrequent table hygiene, there is also potential confounding with prior MRSA SSTI (see Table 12). However, most importantly, there was a statistically significant stratum specific interaction between campus, sharing lotion, and postmatriculation MRSA SSTI with the weighted Mantel-Haenszel *OR* significantly varying from unity, $\chi^2(1) = 6.75$, $p = 0.009$. Attendance at Campus 6 and sharing lotion had a stratum specific *OR* of 29.000, 95% *CI* = [0.185, 2347.222], with potential confounding and effect modification. Because of potential effect modification, the pooled Mantel-Haenszel odds ratio–though statistically significantly different from unity–is not appropriate to use as an adjusted measure of association for campus and the strata should be viewed separately. See Table 12 for crude odds ratios, stratum specific estimated odds ratios, and χ^2 statistics regarding the Mantel-Haenszel odds ratio. The null hypothesis for RQ3 is not rejected overall. There is no association between sharing lotion and self-reported postmatriculation MRSA SSTI in this sample of students from nine chiropractic college campuses. There is, however, a stratum-specific interaction between campus, sharing lotion, and postmatriculation MRSA SSTI.

RQ4. Is sharing of patient practice gowns significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI?

In Chapter 3, I assumed that 25.5% of chiropractic students would report sharing gowns, based on prior research. In this study, 36/312 students, or 11.5%, reported sharing gowns, which was fewer students than expected.

Fisher's exact test for association between sharing gowns and self-reported MRSA SSTI was used. There was no statistically significant association between sharing gowns and MRSA SSTI after starting chiropractic college, crude *OR* = 0.000, 95% *CI* [0.000, 15.015], $p = 1.000$. Stata (Small Stata version 14.1) could not produce an exact 95% confidence interval for this variable because of zero count cells, so this odds ratio includes Cornfield values reported by Stata instead of exact values. The Mantel-Haenszel method was used to assess for stratum specific effects. There were ten 2 x 2 x *k* tables for this research question, the results of which are provided in Appendix J. There was no confounding present nor interaction effects. None of the values in these analyses were significant for this variable. The null hypothesis for RQ4 is not rejected. There is no association between sharing gowns and self-reported postmatriculation MRSA SSTI in this sample of students from nine chiropractic college campuses.

RQ5. Is stage of chiropractic education (institution of patient care or not) significantly different ($p < 0.05$) between chiropractic students with and without self-reported diagnoses of postmatriculation MRSA SSTI?

In Chapter 3, I assumed that 40% of chiropractic students would report having initiated patient care in their education. In this study, 89/312 students, or 28.5%, reported having initiated patient care, somewhat fewer than expected.

Fisher's exact test for association between stage of education (initiation of patient care) and self-reported MRSA SSTI was used. There was no statistically significant association between stage of education and MRSA SSTI after starting chiropractic college, crude *OR* = 2.523, 95% *CI* [0.032, 198.891], $p = 0.490$. The Mantel-Haenszel method was used to assess for stratum specific effects. There were ten 2 x 2 x *k* tables for this research question, the results of which I provide in Appendix J. Strata with potential confounding or effect modification are noted in Table 12. There was potential confounding regarding the following strata: campus, age, and prior MRSA SSTI. For these variables, see Table 12 for crude odds ratios, Mantel-Haenszel weighted estimated odds ratios, stratum specific estimated odds ratios, and χ^2 statistics regarding the Mantel-Haenszel odds ratio. None were significant. The null hypothesis for RQ5 is not rejected. There is no association between stage of education and self-reported postmatriculation MRSA SSTI in this sample of students from nine chiropractic college campuses.

After rendering fifty 2 x 2 x *k* tables to assess for strata specific estimators and pooled Mantel-Haenszel estimates, two regression models were produced. Regression models predict outcome rather than assess association (Lund Research Ltd., 2013a). I constructed the first model using the independent variables as well as any control variables significant with $p < 0.20$ in univariate analysis (Campus 6 and history of prior MRSA SSTI). The second model, constructed using the variables that were significant in strata specific assessment, is described in Additional Tests of Hypotheses.

First, I conducted a binary logistic regression to ascertain the effects of stage of education, sharing gowns, sharing lotion, infrequent hand hygiene, infrequent table hygiene, attendance at Campus 6, and history of prior MRSA SSTI on the likelihood that participants experienced self-reported, postmatriculation MRSA SSTI. The logistic regression model was statistically significant, χ^2 (7) = 18.158, $p = 0.011$. The model explained 75.8% (Nagelkerke R^2) of the variance in self-reported MRSA SSTI and correctly classified 99.7% of cases. Sensitivity was 50.0%, specificity was 100.0%, positive predictive value was 100.0%, and negative predictive value was 99.7%. Of the seven variables, none were statistically significant. These unusual values appear because so few cases were detected; assuming all of the students were negative for postmatriculation MRSA SSTI would be correct ≈99% of the time (exact percentage not reported to conceal the number of cases, as there were fewer than five cases detected).

Additional Tests of Hypotheses That Emerged On Analysis

An additional binary logistic regression was performed because of the interaction to ascertain the effects of sharing lotion and attendance at Campus 6 on the likelihood of postmatriculation MRSA SSTI. The model was statistically significant, χ^2 (2) = 12.645, p = 0.002, explaining 53.2% (Nagelkerke R^2) of the variance in self-reported MRSA SSTI, and correctly classifying 99.4% of cases. Sensitivity was 50.0%, specificity was 99.7%, positive predictive value was 100.0%, and negative predictive value was 99.7%. The two variables were not statistically significant, with sharing lotion, $p = 0.053$.

Last, I conducted an additional Fisher's Exact Test for Campus 6 and prematriculation MRSA SSTI to determine if univariate association with Campus 6 might reflect a disproportionate distribution of students enrolling with this risk there, perhaps leading to a recommendation of preenrollment screening. There was no association between prior MRSA and attendance at Campus 6 ($p = 1.000$, 2-sided test). This was also the case for stratum specific effects (Campus 6 x prior MRSA x post MRSA, $p = 0.320$).

Summary

Half (9/18) of all U.S. chiropractic college campuses agreed to participate in this study, and 312 students ultimately completed the survey–representing ≈7.9% of the students on these campuses (312 / ≈3,945). I conducted univariate analysis; one variable was significantly associated with postmatriculation MRSA SSTI: attendance at Campus 6 ($p = 0.010$). One other variable was significant in univariate analysis at $p < 0.20$, the preestablished cut-off for inclusion in the binomial logistic regression model: prior MRSA SSTI ($p = 0.063$). I conducted stratum specific analysis, producing fifty 2 x 2 x k tables. Potential confounding was detected in a few strata as reported, and stratum specific odds ratios and pooled estimates were provided in Table 12 and Appendix J. Importantly, a statistically significant interaction was detected between campus, sharing lotion, and postmatriculation MRSA SSTI, with the Mantel-Haenszel *OR* significantly varying from unity, χ^2 [1] = 6.75, $p = 0.009$–but with this weighted *OR* inappropriate to use as an adjusted measure of association because of the potential confounding and effect modification detected with Campus 6 (*OR* = 29.000, 95% *CI* = [0.185, 2347.222], compared to the crude *OR* of 4.636, 95% *CI* = [0.058, 365.303], $p = 0.327$ for the overall association between sharing lotion and MRSA SSTI).

I produced a binomial logistic regression model using the independent variables and control variables significant at $p < 0.020$ as potential predictors of the dependent variable. While this logistic regression model was statistically significant, χ^2 (7) = 18.158, $p = 0.011$, none of the variables in the model were found to be significant. The same occurred when I constructed an additional binomial logistic regression model using the variables that had the significant interaction in stratum specific analysis: the model was significant, but no contributing variables were significant.

The null hypothesis was not rejected on any of the research questions, and no individual predictors were significant in regression models, though a stratum specific interaction effect was revealed during Mantel-Haenszel analysis. In Chapter 5, I discuss the importance, limitations, and implications of these findings, and provide recommendations and discuss impact on social change as appropriate.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

In previous chapters I provided evidence to demonstrate that chiropractors have not historically appreciated or participated in mainstream infection control or clinical hygiene activities, that chiropractic students engage in hundreds of hours of skin contact during training in a setting where clinical hygiene is underused, and that MRSA has become the most common cause of cultured SSTIs in primary care clinics and emergency rooms. I examined the intersection of these phenomena; through this quantitative, cross-sectional study I obtained the first correlation of infection control hygiene behaviors (frequency of hand and table hygiene, sharing of lotions/lubricants, and sharing of patient practice gowns) and initiation of patient care with self-reported MRSA SSTI in chiropractic students. The purpose of this study was to reveal the incidence of self-reported MRSA SSTI in chiropractic students, as well as associated infection control and other factors, consistent with the epidemiologic triad.

Consistent with the epidemiologic triad, person and place factors proved important. In univariate analysis, Campus 6 (place factor) where all cases were detected was associated with MRSA SSTI, $p = 0.010$. In stratum specific analysis, potential confounding and effect modification were detected between campus (place factor), sharing lotion (person factor), and MRSA SSTI. Specifically, a statistically significant interaction was detected between campus, sharing lotion, and postmatriculation MRSA SSTI, with the Mantel-Haenszel combined *OR* significantly varying from unity, χ^2 [1] = 6.75, $p = 0.009$. The weighted Mantel-Haenszel *OR* is inappropriate to use as an adjusted measure here because of potential confounding and effect modification detected with Campus 6 (*OR* = 29.000, 95% *CI* = [0.185, 2347.222], compared to the crude *OR* of 4.636, 95% *CI* = [0.058, 365.303], p = 0.327 for the association between sharing lotion and MRSA SSTI), and these strata should be viewed separately. There was no other association between any other assessed factors and MRSA SSTI, though some potential confounding was detected in stratum specific analysis in various strata. Person (sharing lotion) and place (Campus 6) characteristics with biologic plausibility interacted. None of the independent variables in the research questions were associated with self-reported diagnoses of postmatriculation MRSA SSTI in this sample of 312 chiropractic students from nine U. S. chiropractic college campuses. Fewer than five cases of self-reported, postmatriculation MRSA SSTI were reported among these students. No variables in regression models were significant.

Interpretation of the Findings

In this section I describe the relationships of study findings to prior knowledge in the discipline. Additionally, I analyze and interpret the findings in the context of the conceptual framework of the epidemiologic triad.

Relationship of Study Findings to Prior Knowledge

It is important to understand how study findings confirm, disconfirm, or extend prior knowledge in the discipline. In Chapter 2, I reviewed knowledge in the discipline; in this discussion I reference information from that Literature Review.

The first important finding is the overall incidence of self-reported MRSA SSTI in this population of 312 U.S. chiropractic students. The incidence was lower than expected based on prior literature. The actual incidence will not be reported because fewer than five cases were revealed, and per the IRB approval for this study, no cell with a value below five will be reported individually. However, even if there had been five cases of MRSA SSTI, the multiyear incidence in chiropractic students would have been five cases per 312 students, or 1.6% of students affected at any point since matriculation. From the literature, the annualized MRSA SSTI incidence in a variety of populations has ranged from 4.2% and 8.1% in Army recruits in training (Ellis et al., 2007; Ellis et al., 2004), to 1.8% in a population-based assessment in an integrated health system (Ray et al., 2013), to 0.79% in college athletes (Creech et al., 2010), to 8% in a 4-hospital health system based on surveillance cultures (Ridgeway et al., 2013). As noted, the national incidence of MRSA SSTI in the general population is still unknown (CDC, 2013c). In the present study, despite the presence of risk factors in many participants, the overall rate of MRSA SSTI was below 1.6% over the entire postmatriculation period. This was a multiyear incidence–and therefore lower than any of the annual rates in any of these comparison groups except perhaps the college athletes. In that sense, these findings extend knowledge by assessing MRSA SSTI incidence in a new population–graduate students in a manual therapy program–and confirm knowledge by demonstrating that college students at both the undergraduate and graduate level appear to have a lower incidence of MRSA SSTI than other populations. The latter finding is consistent with literature revealing that education contributes significantly to the ability to predict mortality risk and that inclusion of educational status can significantly improve the predictive ability of comorbidity indices (Chapman et al., 2015). Comorbidity predictions are influenced by education; a population entirely composed of graduate health students might therefore have been expected to experience a variety of health challenges–including MRSA SSTI–less frequently than other populations.

I noted in the Literature Review in Chapter 2 that MRSA carriage had not been explored in many different types of U.S. healthcare students (including chiropractic students) and I provide tables of these studies in healthcare students inside and outside of the United States in Appendices D, E, and F. In preparing these study conclusions, I located four sources that were not part of my literature review, either because of publication after the main literature review was conducted (Lum et al., 2014; Rohde et al., 2014), or because they were not produced with the original search terms (Miramonti et al., 2013; Schwartz, 2011). These sources were a study of MRSA nasal carriage among U.S. emergency medical technician (EMT) students (Miramonti et al., 2013), a study of MRSA nasal carriage among U.S. physician assistant students (Schwartz, 2011), a study of MRSA nasal carriage among U.S. nursing students (Rohde et al., 2014), and a study of MRSA carriage among first-year U.S. pharmacy students (Lum et al., 2014). In the study of EMT students (Miramonti et al., 2013), 5.3% of EMT students were found to be MRSA nasal carriers. In the study of pharmacy students (Lum et al., 2014), 4.2% of nasal cultures revealed MRSA. In the study of physician assistant students (Schwartz, 2011), none of the students were nasal MRSA carriers. In the study of nursing students (Rohde et al., 2014), 1.2% of students in the first assessment and 0% in all subsequent assessments were found to be MRSA nasal carriers. However, these studies–as with others described in the Literature Review–also did not regard SSTI, the outcome of interest in my study. My study remains the only study of which I am aware to inquire about MRSA SSTI infection history in healthcare students. In this regard, my study builds upon and expands prior knowledge into an experienced health outcome rather than carriage only.

Studies have assessed initiation of patient care in health professions students and changes in MRSA carriage. Again, my study instead assessed the association with the outcome of MRSA SSTI, not merely carriage. In the United States, studies of MRSA nasal carriage that I described in Chapter 2 did not show that initiating patient care led to a significant increase in carriage (Chamberlain & Singh, 2011; Slifka et al., 2009). This pattern was again seen in a study published since the main search described in my Literature Review (Rohde et al., 2014). Studies outside the United States have variably fared somewhat differently, as seen in Appendix E. My findings in this study were similar to the studies in the United States, confirming prior research related to MRSA. Importantly, where those studies regarded MRSA nasal carriage, my work with this study permits those findings to extend into perhaps the more important outcome of MRSA SSTI. Initiation of patient care was not associated with MRSA SSTI in this population of 312 chiropractic students attending nine U.S. chiropractic college campuses.

In Table 4 in Chapter 2, I reviewed an extensive list of literature-based risk factors associated with MRSA SSTI. Many of these risk factors were assessed as independent variables or control variables in the present study. The following variables, found to be associated with MRSA SSTI in some prior studies per Table 4, were found to be potential confounders in the relationship between at least one of the independent variables and MRSA SSTI: age, gender, and prior MRSA SSTI. However, in two different logistic regression models, none of the variables in the study were significantly predictive of MRSA SSTI. This confirms prior understanding: There is no currently accepted risk factor questionnaire for MRSA SSTI in the community (Macario et al., 2010). Despite the fact the MRSA is the most common cause of cultured SSTI in primary care clinics and emergency rooms in the United States, as extensively reviewed in Chapters 1 and 2, it is still not clear what factors are consistently associated with this outcome. Additional study is still needed (Lowy, 2013).

One study of MRSA SSTI found a cluster of cases in one community area (Hota et al., 2007). Through this study, I confirmed that MRSA SSTI is able to cluster geographically, finding attendance at Campus 6 associated with MRSA SSTI in univariate analysis ($p < 0.010$) and finding potential confounding and effect modification between campus, sharing lotion, and MRSA SSTI. I did not assess household level data, so it is not known if the cases detected in this study shared residence. Shared residence was evaluated in other studies (Bearman et al., 2010; Nerby et al., 2011; Uhlemann et al., 2011). Sharing of lotions and ointments was previously found to be associated with MRSA transmission in households (Nerby et al., 2011). This factor was also supported by this study as noted here, with the interaction between campus, sharing lotion, and MRSA SSTI. Sharing lotions, gels, and ointments has been suspected as a factor in previous MRSA SSTI outbreak investigations (Kazakova et al., 2005).

Previous studies have found an association with age and MRSA SSTI, as reviewed in Table 4. I found no such association in univariate analysis in this study, as seen in Table 11, though some potential confounding was noted, as seen in Table 12. In this case, the study was not large enough--given the small number of cases detected--to permit me to confirm or disconfirm prior knowledge. However, through future study, researchers could assess this phenomenon in chiropractic practitioners, who would very likely be of greater average age. This will be further discussed in Recommendations.

Previous studies assessed hygiene factors in chiropractic students. The largest of these studies at three chiropractic colleges found that the 22% of students were infrequent hand sanitizers and 71% were infrequent table sanitizers (Evans, Ramcharan, Ndetan et al., 2009). My study, performed several years later at nine U.S. chiropractic colleges, permitted me to confirm these findings. In my study, 32.7% of students were infrequent hand sanitizers and 67.0% of students were infrequent table sanitizers. Through this study, I extended knowledge by assessing the relationship between these infection control behaviors and postmatriculation MRSA SSTI. In this case, there was no relationship found. I also showed that despite a new ACA policy regarding clinical hygiene in 2010, the hygiene practices of chiropractic students have not improved. As I note in recommendations, the ACA could consider the effectiveness of its outreach.

Prior studies assessed the relationship between sharing clothing and MRSA nasal carriage. One such study evaluated nearly 1,000 undergraduate students (Bearman et al., 2010). In that study, 25.5% of participants reported sharing clothing. That finding was used as the basis for power calculations for this study. In this study, 11.5% of participants reported sharing one specific form of clothing: the patient gown. Chiropractic students carry these gowns with them and use them in various lab classes as they study. I found a smaller percentage of clothing sharers than Bearman et al. (2010), but I only asked about one specific form of clothing–so these percentages may not be directly comparable. Through this study I confirmed that sharing clothing occurs among students, but I did not find any relationship with the outcome of interest.

The same study of undergraduates (Bearman et al., 2010) found that 42.4% reported sharing bar soap in their households. This value was used for power calculations in the present study relative to sharing lotions, as there were not other data to draw from for this population. In this study, I found that 17.9% of chiropractic students reported sharing lotion. This was an extension of knowledge. I am unaware of this having been assessed among manual therapy students previously. From an infection control perspective, nearly 1 in 5 students of this manual, skin-contact based therapy share lotions. I did not ask about "double-dipping"–or contacting the reservoir of lotion or the dispensing head directly with the hands or treatment instruments. These are infection control behaviors that could be studied further; the present study did permit me to extend knowledge in the discipline by revealing how common this sharing of lotions, lubricants, and emollients is.

In summary, through this study I extended and confirmed existing knowledge in the discipline and did not disconfirm any knowledge in the field. MRSA SSTI was not common in this population. The role for further study of the use and sharing of lotions in this study environment was highlighted based on the findings of this study and the results of prior study. The role for assessment of the quality of the ACA's outreach to chiropractors was noted. Next, I will analyze study findings in context of the epidemiologic triad.

Analysis and Interpretation of Findings in Context of Conceptual Framework

The conceptual framework for the current study was the epidemiologic triad of person, time, and place. Epidemiology concerns the distribution of the determinants of health, which have person, time, and place characteristics (Merrill, 2013; Porta, 2008; Rohrer et al., 2013). In this case, the framework undergirded the supposition that chiropractic students with MRSA SSTI would likely share commonalities that predisposed to infection not shared at the same frequency by those without SSTI. Further, the framework held that these factors should be able to be ascertained (Merrill, 2013) and that these factors should be biologically plausible and not strain credulity (Hill, 1965). My study specifically included the elements of the epidemiologic triad as independent and control variables: person (frequency of hand and table hygiene, sharing of lotion and patient practice gowns, gender, age, race, military service, jail, history of intravenous drug use, and healthcare exposures), place (nation of origin and chiropractic college campus), and time (stage of education/initiation of patient care).

Through univariate analysis, there initially appeared to be a relationship between an epidemiologic triad factor of place (Campus 6) and MRSA SSTI, $p = 0.010$. Like Rohrer et al. (2013), who found that time and place factors initially seemed significant in univariate analysis in that study, but later found the association with time to be an artifact of place characteristics, I initially found a place factor significant in univariate analysis (specifically, matriculation at Campus 6), but later found that a person characteristic (sharing lotion) confounded this place relationship and interacted with Campus 6 and MRSA SSTI. In regression analysis, no individual variable in the present study ultimately proved significantly predictive of MRSA SSTI. If I had not considered the entire epidemiologic triad in the design of this study, but had simply examined the association between location and MRSA SSTI, an association with Campus 6 might have been noted. However, by evaluating person and time factors, and by using more than univariate analysis, I found that place and person factors interacted and that no variable achieved predictive significance in regression, despite initial univariate analysis.

As reported in Chapter 2, Snow (1855) understood that cholera could appear and cluster anywhere conditions of person, time, and place were right. In this study, Campus 6 represented a small potential cluster, where all of the few detected cases in this study were found. The feature of sharing lotion interacted with campus. Campus clustering and sharing lotion are biologically plausible in connection with this infectious organism and do not strain credulity (Hill, 1965). In univariate analysis, prior MRSA SSTI was not significant ($p = 0.063$). Had this feature proven significant, it also would not have strained credulity to find past infection associated with later infection. Again, as noted, none of the variables were predictive of MRSA SSTI in logistic regression.

Whatever variables may ultimately be found to be associated with MRSA SSTI in this population and in community dwelling U.S. adults in general if this is ever determined, these variables will be consistent with the epidemiologic triad. I was not successful in uncovering what those variables may be–in part because this population was healthier than expected and many fewer infections were detected than expected. Other methods might prove more successful at infection detection in the future, such as a medical records review or prospective, active surveillance.

Though there was no professional clinical hygiene guidance for typical patient encounters in the chiropractic profession prior to 2010, and though MRSA has been isolated frequently in chiropractic treatment environments, and though students have frequent skin contact with one another in training–all of which I discussed in Chapter 1 and 2 and all of which theoretically provided the opportunity for amplification consistent with principles discussed in Chapter 2 (Aiello et al., 2006)–MRSA SSTI does not appear to be problematic in this population. The person, place, and time characteristics assessed in this study were not significant beyond univariate analysis and stratum specific interaction.

Limitations of the Study

In this section, I discuss limitations of the study. These are discussed as limitations to generalizability, validity, and reliability. Last, I review the problem of small numbers.

Generalizability

While I was successful in including chiropractic college campuses from across the United States in the study, there are some important limitations to generalizability in this study. First, this study ultimately applies specifically to the 312 participants, and more generally to the nine chiropractic campuses that agreed to participate and from which participants were drawn. Because these campuses do contain approximately 40% of the

U.S. chiropractic student body attending half (9/18) of the U.S. chiropractic campuses, there may be some generalizability to the entire U.S. chiropractic student population.

This study had an ≈8.7% initial response rate; there is no way to know how results may have varied if there had been additional respondents. Providing some reassurance is the fact that those who responded did appear to be reasonably similar demographically to the general chiropractic student body (see Table 10).

Given these considerations, the findings do apply to the 312 students surveyed, and with progressively less generalizability to all the chiropractic students at these nine campuses, and to all U.S. chiropractic students.

Validity

As I discussed in Chapter 2, MRSA risk factor studies have typically suffered from a lack of validity testing of their questionnaires (Macario et al., 2010). This study has the same difficulty. Given that understanding, I frequently asked yes/no questions with this questionnaire in an attempt to reduce ambiguity and enhance validity--and also frequently asked questions about a 12-month timeframe to improve recall and enhance validity (Bradburn, Sudman, & Wansink, 2004). Demonstrating that these efforts to provide a clear questionnaire may have been successful, I did not receive any questions from any participants or potential participants about questionnaire content. However, this study has the same problems as previous MRSA risk factors studies regarding questionnaire validation. One MRSA risk factor study that discussed the problem of MRSA questionnaire validity did try to validate their questionnaire and discussed their findings (Macario et al., 2010). The questionnaire in my study was not validated, similar to most other MRSA risk factor questionnaires. Construct validity in this study stemmed from basing the questionnaire in preexisting questionnaires (Bearman et al., 2010; CDC, 2013b; Evans & Breshears, 2007).

There is no direct way to assess the trustworthiness of the self-reported data in this study. Perhaps students did not respond truthfully or abandoned the survey when reaching questions about infection–or simply chose not to participate in the first place. Providing confidence here is that 91% of students who entered the survey completed it (see Figure 2)–so few seemed to be turned away in concern for the questions that were asked or failed to complete for any other reason, including exclusion.

Self-reported data often provides information that is important and cannot be obtained in any other way, and questionnaires of sensitive information are able to obtain valid data (Brener et al., 2003; Zimmerman & Langer, 1995), particularly if confidentiality is assured (Aquilino et al., 1998; Crutzen & Göritz, 2011; Macario et al., 2010; Tourangeau & Smith, 1998). Online survey responses in the present study were confidential and the survey system was secure (Qualtrics QLite version). Students were assured that no data category with less than five responses would be reported individually. There were no confidentiality violations of which the author is aware.

Reliability

Reliability is a limitation of this study. While rates of clinical hygiene and infection control risk factors among participants were within range of what was expected based on previous studies, the small number of MRSA SSTI cases detected makes the findings unreliable. This will be discussed further momentarily in the discussion of the problem of small numbers. Here, as noted, findings of risk factor prevalence were similar to the studies cited as background in this study, and the questionnaire was worded similarly or identically to questions in those studies. However, the wide confidence intervals in this study, cells with fewer than five (and often zero) values, and difficulties with stratum specific analyses draw attention to the problem of reliability. Perhaps most telling, in statistical analysis the cases were so infrequent that the regression models marked the cases as the outliers. Even a few additional cases could have changed study findings, reducing certainty of their reliability.

The Problem of Small Numbers

Study findings highlight the problem of small numbers; there were many fewer cases than had been expected based on the literature. As already noted in the discussion, this likely stemmed from the association of education and health (Chapman et al., 2015)–a study including an entirely graduate student population should probably have been expected to have healthier than average participants. Finding a small number of cases meant that the statistics reported here are likely unreliable; even very few additional cases could have changed the findings. The confidence intervals reveal this–they are quite wide in many cases, casting doubt that the associations detected are real, or raising the concern that other associations might instead exist and would have been revealed if more students had participated or if the study had been larger in scale. Because fewer cases were detected than were anticipated (and for which the study was powered), too many cells contained zero, and too many values could not be calculated–rendering some confidence intervals unable to be ascertained and causing strata to be unable to be calculated in stratum specific analyses. In summary, the largest limitation is that fewer cases were detected than expected–the study was powered with other expectations. A larger study would need to be performed to answer the questions with greater certainty, and to provide confidence in the reliability of the results. A larger study would likely enhance generalizability as well. Other methods, such as medical records review or prospective, active surveillance could reduce potential misclassification bias and also help enhance the reliability of findings. Future studies could incorporate these methods.

Recommendations

There are several recommendations for further research grounded in the strengths and limitations of this study as well as the Literature Review as presented within Chapter 2. These recommendations do not exceed the study boundaries.

First, all of the cases detected in this study were present on one campus (Campus 6). While there were few cases detected, which did not represent a reportable cluster, this campus might bear further individual follow up study for the benefit of students there and for the benefit of the institution. Was environmental contamination present (could environmental sampling be done)? Was hand sanitation as prevalent as reported (could an observational study assist)? Have additional cases occurred (were these isolated cases or part of a larger pattern just underway)? Is active surveillance needed? Follow up by Campus 6 is recommended, and the author will inform the appropriate administrative contact at Campus 6 that all of the few detected cases were on their campus, and that further investigation or action at their institution could be warranted.

The present study appears to reveal that MRSA SSTI is not a problem among the students of chiropractic, the largest healthcare profession outside of mainstream medicine, despite professional attitudes and practices regarding infection control. It is recommended that if it is determined by policymakers or stakeholders that is important to more fully understand the incidence of MRSA SSTI among this population, a comprehensive, prospective, longitudinal assessment could be conducted at sufficient scale in U.S. chiropractic colleges, utilizing the current study of 312 students at nine U.S. chiropractic college campuses as pilot data to guide powering of the larger study. This larger study could also use medical records review as part of active surveillance to minimize classification bias.

In this study I found that MRSA SSTI is not a problem among chiropractic students, as just described. Perhaps an important related question to consider is if the risk of MRSA SSTI in chiropractic practitioners remains low over time. The colleges teach principles of hygiene to meet the demands of accrediting agencies, as described. However, as also described, chiropractic students and practitioners may hold beliefs and have practices that are not consistent with mainstream infection control and clinical hygiene. Given this, further study could evaluate chiropractic practitioners and assess if the risk for MRSA SSTI increases the longer they have been away from the colleges and if hygiene behaviors taper. My study could again serve as pilot data to guide the powering of that study.

In this study I found biologically plausible potential confounding and interaction between sharing lotion, attendance at Campus 6, and MRSA SSTI. As the use of lotions and emollients is common to the largest manual therapy professions (chiropractic, physical therapy, and massage therapy) the prospect of lotion as a contaminant or vector could be further studied. How frequently do students directly contact the reservoir of an open container with their hand rather than with a clean, non-reusable implement to extract lotion, thereby potentially contaminating the contents? How frequently do students directly contact the nozzle of a lotion pump with their hands, thereby potentially contaminating the contents? How frequently are these smaller lotion containers refilled from larger containers, and is this done in a fashion that prevents contamination? Do the lotions most frequently used in manual therapy serve well as media for infectious pathogens? It is recommended that these questions be evaluated to further assess the risk that lotions, emollients, and lubricants may pose in manual therapy training and practice, in light of the findings in this study.

Last, the impact of the ACA clinical hygiene policy discussed in Chapter 1 and 2 could be assessed. The chiropractic profession has not historically been aligned with mainstream infection control beliefs and behaviors, as described in Chapter 2. However, as noted in Chapter 2 and consistent with findings in this study, it has also been the case that there has not been documented transmission of nosocomial infection in chiropractic clinics at essentially any scale. In an environment where beliefs about infection control may vary from the mainstream, and where nosocomial infections do not occur to contradict this belief, is the ACA’s policy regarding clinical hygiene having any effect on practice? This study showed that students frequently did not report exercising hand or table hygiene between practice partners and patients – and these rates were similar to earlier studies that predated the ACA's policy (Evans & Breshears, 2007; Evans, Ramcharan, Ndetan et al., 2009). How do these and other infection control behaviors translate from student training environments into typical chiropractic practice in the United States–and is educational or postgraduate practice changing in the wake of this ACA policy? Cross-sectional (survey), observational, and longitudinal studies could each assess aspects of that question with varying sophistication and confidence depending on the resources deployed. It is recommended that the ACA assess the impact of the policy on practice. If it is determined that policies about fundamental items such as clinical hygiene are not impacting the practice of students or practitioners, then perhaps the ACA could consider evaluation of the effectiveness of its outreach and education programs.

Implications

This study has implications for positive social change–and these revolve around practice and training recommendations stemming from research findings. The three main implications for positive social change follow.

1. Senior administration at Campus 6 will be informed that all of the cases detected in this study–though few–were present on their campus. This will give leadership at this campus the opportunity to self-assess regarding the safety of their students and practices. Campus administration will be referred to the guideline suggested by Evans, Ramcharan, Ndetan et al. (2009) for hygiene in chiropractic practice. Campus administration will also be informed of the potential confounding and interaction regarding sharing lotion on their campus, which relates to the next recommendation. This will allow positive

social change to occur at one campus with regards to assessment for a potential MRSA SSTI cluster, implementation of existing infection guidelines, and enhancement of guidelines through prevention of sharing lotion (more immediately below).

2. Administrative contacts at each participating campus will be provided an Executive Summary of findings from this study–and will particularly receive recommendation concerning the sharing of lotion by students in training. With the potential confounding and interaction between sharing lotion, campus, and MRSA SSTI detected in this study, all of the campuses should be aware of the possible infection control implications in this relatively easy to implement change of restricting the sharing of lotion. This will allow positive social change to occur at these chiropractic colleges with regards to this simple infection control procedure.
3. The ACA will be informed of study findings regarding sharing of lotion and the frequency of hygiene practices detected in this study. I will recommend that the ACA periodically remind members of the hygiene guidelines and consider addition of lotion protocols for infection control. This will allow positive social change that could impact chiropractors in practice.

These suggestions are simple and are based in the findings of this research. These suggestions will permit an individual institution's administration (Campus 6), all participating campus administrations, and the ACA through its membership to translate research into practice with simple steps regarding infection control to benefit students, practitioners, and their patients.

Conclusions

In this study of 312 participating chiropractic students attending 9 of 18 U.S. chiropractic colleges representing about 40% of all U.S. chiropractic students, I found fewer than 5 cases of self-reported, postmatriculation MRSA SSTI. In this study, 32.7% of students reported using hand hygiene infrequently between patients and practice partners, and 67.0% of students reported sanitizing treatment tables infrequently between patients and practice partners. Additionally, 11.5% of participants reported sharing their patient practice gowns, and 17.9% reported sharing lotions, emollients, and lubricants.

I analyzed study data with the epidemiologic triad of person, time, and place as a conceptual model. In univariate analysis, Campus 6 (place factor) where all cases were detected was associated with MRSA SSTI, $p = 0.010$. In stratum specific analysis, potential confounding and effect modification was detected between campus (place factor), sharing lotion (person factor), and MRSA SSTI, with the Mantel-Haenszel *OR* significantly varying from unity, χ^2 [1] = 6.75, $p = 0.009$. However, the weighted *OR* should not be used as an adjusted estimate because of the potential confounding and effect modification detected with Campus 6 (*OR* = 29.000, 95% *CI* = [0.185, 2347.222], compared to the crude *OR* of 4.636, 95% *CI* = [0.058, 365.303], $p = 0.327$ for the association between sharing lotion and MRSA SSTI). There was no other association between any other assessed factors and MRSA SSTI, though some other potential confounding was detected in stratum specific analysis, typically involving age, gender, and prior MRSA SSTI. I constructed two logistic regression models; both were significant ($p < 0.05$) but the composing variables were not. None of the independent variables in the research questions were associated MRSA SSTI. No other significant associations with any variable were detected.

Three steps will be taken to ensure this study produces positive social change. First, Campus 6 administration will be informed that all cases occurred on their campus, and evidence-based clinical hygiene guidance will be provided. Campus administration will be recommended to prohibit sharing of lotion between students. Campus administration may elect to assess if other cases have occurred and make necessary changes in clinical hygiene for the safety of students. Second, administrative contacts at all participating colleges will be provided a summary of findings with recommendations regarding preventing the sharing of lotions as an infection control measure. Third, the ACA will be provided study findings to encourage the updating of the clinical hygiene guidance provided to their members to include manual therapy lotion etiquette. These simple steps will permit positive changes that could help prevent MRSA SSTI in students at U.S. chiropractic colleges and facilitate precautionary steps that could potentially prevent these infections in practitioners and patients.

MRSA is a key organism impacting human health. Chiropractors have not historically embraced mainstream infection control practices fully. In this study, I assessed the infection control and hygiene practices of chiropractic students, as well as the association with self-reported, postmatriculation MRSA SSTI. While few MRSA SSTIs occurred among participants, simple behavior changes–such as students of manual therapy not sharing lotions, emollients, and lubricants–could potentially reduce the occurrence of MRSA SSTI. This permits positive social change; administrative personnel at Campus 6 and all participating campuses--and the ACA through its membership--can translate research into practice with simple improvements to infection control to the benefit of students, practitioners, and patients.

References

Adesida, S. A., Abioye, O. A., Bamiro, B. S., Brai, B. I. C., Smith, S. I., Amisu, K. O., ... Coker, A. O. (2007). Associated risk factors and pulsed field gel electrophoresis of nasal isolates of *S. aureus* from medical students in a tertiary hospital in Lagos, Nigeria. *Brazilian Journal of Infectious Diseases, 11*(1), 63-69. doi:10.1590/s1413-86702007000100016

Aiello, A. E., Lowy, F. D., Wright, L. N., & Larson, E. L. (2006). Meticillin-resistant *Staphylococcus aureus* among US prisoners and military personnel: Review and recommendations for future studies. *Lancet Infectious Diseases, 6*, 335-341. doi:10.1016/s1473-3099(06)70491-1

Alam, M. T., Read, T. D., Petit III, R. A., Boyle-Vavra, S., Miller, L. G., Eells, S. J., ... David, M. Z. (2015). Transmission and microevolution of USA300 MRSA in U. S. households: Evidence from whole-genome sequencing. *mBIO, 6*(2), e00054-15. doi:10.1128/mBio.0054-15

American Chiropractic Association. (2010). *ACA House of Delegates: Chiropractic profession qualified to fill the gaps in primary health care–ACA's governing body approves policies and charts progress at its annual meeting*. Retrieved from http://www.acatoday.org/press_css.cfm?CID=4165

American Chiropractic Association. (2011). *Current policies.* Retrieved from http://www.acatoday.org/level2_css.cfm?T1ID=10&T2ID=117

American Chiropractic Association. (2015). *What is chiropractic?* Retrieved from https://www.acatoday.org/level2_css.cfm?T1ID=13&T2ID=61

American Public Health Association. (2000). *Policy no. 20023: The need for continued and strengthened support for immunization programs.* Retrieved from http://www.apha.org/advocacy/policy/policysearch/default.htm?id=230

Ammerlaan, H. S. M., Kluytmans, J. A. J. W, Wertheim, H. F. L., Nouwen, J. L., & Bonten, M. J. M. (2009). Eradication of methicillin-resistant *Staphylococcus aureus* carriage: A systematic review. *Clinical Infectious Diseases, 48*(7), 922-930. doi:10.1086/597291

Anderson, R. (1990). Chiropractors for and against vaccines. *Medical Anthropology, 12*, 169-186. doi:10.1080/01459740.1990.9966020

Aquilino, W. S., Supple, A. J., & Wright, D. L. (1998). A comparison of computer-assisted and paper-and-pencil self-administered questionnaires in a survey on smoking, alcohol, and drug use. *Public Opinion Quarterly, 62*(3), 331-353. doi:10.1086/297849

Baggett, H. C., Hennessy, T. W., Rudolph, K., Bruden, D., Reasonover, A., Parkinson, A., . . . Butler, J. C. (2004). Community-onset methicillin-resistant *Staphylococcus aureus* associated with antibiotic use and the cytotoxin Panton-Valentine leukocidin during a furunculosis outbreak in rural Alaska. *Journal of Infectious Diseases, 189*(9), 1565-1573. doi:10.1086/383247

Barnes, P. M., Bloom, B., & Nahin, R. L. (2008). Complementary and alternative medicine use among adults and children: United States, 2007. *National Health Statistics Report*, *12*, 1-23. doi:10.1037/e623942009-001

Bearman, G. M., Bryant, K., Leekha, S., Mayer, J., Munoz-Price, L. S., Murthy, R., ...

White, J. (2014). Healthcare personnel attire in non-operating room settings. *Infection Control and Hospital Epidemiology, 35*(2), 107-121. doi:10.1086/675066

Bearman, G. M., Rosato, A. E., Assanasen, S., Kleiner, E. A., Elam, K., Haner, C., & Wenzel, R. P. (2010). Nasal carriage of inducible dormant and community-associated methicillin-resistant *Staphylococcus aureus* in an ambulatory population of predominantly university students. *International Journal of Infectious Diseases, 14*(supplement 3), e18-e24. doi:10.1016/j.ijid.2009.09.005

Begier, E. M., Frenette, K., Barrett, N. L., Mshar, P., Petit, S., Boxrud, D. J., … Hadler, J. L. (2004). A high morbidity outbreak of methicillin-resistant *Staphylococcus aureus* among players on a college football team, facilitated by cosmetic body shaving and turf burns. *Clinical Infectious Diseases, 39*(10), 1446-1453. doi:10.1086/425313

Bettin, A., Causil, C., & Reyes, N. (2012). Molecular identification and antimicrobial susceptibility of *Staphylococcus aureus* nasal isolates from medical students in Cartagena, Colombia. *Brazilian Journal of Infectious Diseases, 16*(4), 329-334. doi:10.1016/j.bjid.2012.06.017

Bezold, C., Rowley, W. R., & Bettles, C. (2005). *The future of chiropractic revisited: 2005 to 2015*. Alexandria, VA: Institute for Alternative Futures.

Bifero, A. E., Prakash, J., & Bergin, J. (2006). The role of chiropractic adjusting tables as reservoirs for microbial diseases. *American Journal of Infection Control, 34*(3), 155-157. doi:10.1016/j.ajic.2005.12.007

Bischoff, W. E., Wallis, M. L., Tucker, K. B., Reboussin, B. A., & Sheretz, R. J. (2004). *Staphylococcus aureus* nasal carriage in a student community: Prevalence, clonal relationships, and risk factors. *Infection Control and Hospital Epidemiology, 25*(6), 485-491. doi:10.1086/502427

Blair, E., Sudman, S., Bradburn, N., & Stocking, C. (1977). How to ask questions about drinking and sex: Response effects in measuring consumer behavior. *Journal of Marketing Research, 14*(August), 316-321. doi:10.2307/3150769

Boston University School of Public Health. (*n.d.*). *Confounding and effect measure modification.* Retrieved from http://sphweb.bumc.bu.edu/otlt/MPH-Modules/BS/BS704-EP713_Confounding-EM/BS704-EP713_Confounding-EM_print.html

Boyce, J. D., & Pittet, D. (2002). Guideline for hand hygiene in health-care settings. *Morbidity and Mortality Weekly Report, 51*(RR16), 1-44. Retrieved from http://www.cdc.gov/mmwr/PDF/rr/rr5116.pdf

Bradburn, N. M., Sudman, S., Blair, E., & Stocking, C. (1978). Question threat and response bias. *Public Opinion Quarterly,* 221-234. doi:10.1086/268444

Bradburn, N. M., Sudman, S., & Wansink, B. (2004). *Asking questions: The definitive guide to questionnaire design–for market research, political polls, and social and health questionnaires, revised edition*. San Francisco, CA: John Wiley & Sons, Inc.

Brener, N. D., Billy, J. O. G., & Grady, W. R. (2003). Assessment of factors affecting the validity of self-reported health-risk behavior among adolescents: Evidence from the scientific literature. *Journal of Adolescent Health, 33*(6), 436-457. doi:10.1016/s1054-139x(03)00052-1

Bureau of Labor Statistics. (2014). *Occupational outlook handbook: Chiropracti*c. Retrieved from http://www.bls.gov/ooh/Healthcare/Chiropractors.htm

Burnham, K., Peterson, D., Vavrek, D., & Haas, M. (2009). The impact of microbial surveys on disinfection protocols in a chiropractic college environment. *Journal of Manipulative and Physiologic Therapeutics, 32*(6), 463-468. doi:10.1016/j.jmpt.2009.06.002

Buss, B. F., & Connolly, S. (2014). Surveillance of physician-diagnosed skin and soft tissue infections consistent with methicillin-resistant *Staphylococcus aureus* (MRSA) among Nebraska high school athletes, 2008-2012. (2014). *Journal of School Nursing, 30*(1), 42-48. doi:10.1177/1059840513491785

Busse, J. W., Kulkarni, A. V., Campbell, J. B., & Injeyan, H. S. (2002). Attitudes towards vaccination: A survey of Canadian chiropractic students. *Canadian Medical Association Journal, 166*(12), 1531-1534. Retrieved from http://www.cmaj.ca/ content/166/12/1531.long

Busse, J. W., Morgan, L., & Campbell, J. B. (2005). Chiropractic antivaccination arguments. *Journal of Manipulative and Physiologic Therapeutics, 28*(5), 367-373. doi:10.1016/j.jmpt.2005.04.011

Busse, J. W., Wilson, K., & Campbell, J. B. (2008). Attitudes towards vaccination among chiropractic and naturopathic students. *Vaccine, 26*(49), 6237-6243. doi:10.1016/j.vaccine.2008.07.020

Cadilla, A., David, M. Z., Daum, R. S., & Boyle-Vavra, S. (2011). Association of high-level mupirocin resistance and multidrug resistant methicillin-resistant *Staphylococcus aureus* at an academic center in the midwestern United States. *Journal of Clinical Microbiology, 49*(1), 95-100. doi:10.1128/JCM.00759-10

Calfee, D. P., Salgado, C. D., Classen, D. Arias, K. M., Podgorny, K., Anderson, D. J., ... Yokoe, D.S. (2009). Strategies to prevent transmission of methicillin-resistant *Staphylococcus aureus* in acute care hospitals. *Infection Control and Hospital Epidemiology,* (Suppl. 1), 62-80. doi:10.1086/591061

Campbell, J. B., Busse, J. W., & Injeyan, H. S. (2000). Chiropractors and vaccination: A historical perspective. *Pediatrics, 105*(4), e1-e8. E43. Retrieved from http://pediatrics.aappublications.org/content/105/4/e43

Centers for Disease Control and Prevention. (1999a). Achievements in public health: Control of infectious diseases. *Morbidity and Mortality Weekly Report, 48*(29), 621-629. Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/ mm4829a1.htm

Centers for Disease Control and Prevention. (1999b). Four pediatric deaths from community-acquired methicillin-resistant *Staphylococcus aureus*–Minnesota and North Dakota, 1997-1999. *Morbidity and Mortality Weekly Report, 48*(32), 707-710. Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm4832a2. htm

Centers for Disease Control and Prevention. (2003a). Methicillin-resistant *Staphylococcus aureus* infections among competitive sports participants --

Colorado, Indiana, Pennsylvania, and Los Angeles County, 2000-2003. *Morbidity and Mortality Weekly Report, 52*(33), 793-794. Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5233a4.htm

Centers for Disease Control and Prevention. (2003b). Methicillin-resistant *Staphylococcus aureus* infections in correctional facilities -- Georgia, California, and Texas, 2001-2003. *Morbidity and Mortality Weekly Report, 52*(41), 992-996. Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5241a4.htm

Centers for Disease Control and Prevention. (2010). *Diagnosis and testing of MRSA infections.* Retrieved from http://www.cdc.gov/mrsa/diagnosis/index.html

Centers for Disease Control and Prevention. (2011). *Guide to Infection Prevention for Outpatient Settings: Minimum Expectations for Safe Care.* Retrieved from http://www.cdc.gov/HAI/pdfs/guidelines/standatds-of-ambulatory-care-7-2011.pdf

Centers for Disease Control and Prevention. (2012). *Active Bacterial Core Surveillance (ABCs) report: Emerging Infections Program Network methicillin-resistant* Staphylococcus aureus, *2012*. Retrieved from http://www.cdc.gov/abcs/reports-findings/survreports/mrsa12.pdf

Centers for Disease Control and Prevention. (2013a). *Antibiotic Resistance Threats in the United States, 2013.* Retrieved from http://www.cdc.gov/drugresistance/threat-report-2013/pdf/ar-threats-2013-508.pdf

Centers for Disease Control and Prevention. (2013b). *Invasive Methicillin-Resistant–Staphylococcus aureus Active Bacterial Core Surveillance (ABCs) Case Report–*

2013. Retrieved from http://www.cdc.gov/abcs/downloads/MRSA-case-rpt-form.pdf

Centers for Disease Control and Prevention. (2013c). *Methicillin-resistant Staphylococcus aureus (MRSA) infections: General information about MRSA in the community.* Retrieved from http://www.cdc.gov/mrsa/community/index.html

Chamberlain, N. R., & Singh, V. K. (2011). Prevalence of methicillin resistant *Staphylococcus aureus* in nasal samples from preclinical second year medical students. *Missouri Medicine, 108*(5), 373-376. Retrieved from www.pubmed.com

Chambers, H. F. (2001). The changing epidemiology of *Staphylococcus aureus*? *Emerging Infectious Diseases, 7*(2), 178-182. doi:10.3201/eid0702.010204

Chapman, B. P., Weiss, A., Fiscella, K., Muenning, P., Kawachi, I., & Duberstein, P. (2015). Mortality risk prediction: Can comorbidity indices be improved with psychosocial data? *Medical Care, 53*(11), 909-915. doi:10.1097/MLR.0000000000000428

Chatterjee, S. S., & Otto, M. (2013). Improved understanding of factors driving methicillin-resistant *Staphylococcus aureus* epidemic waves. *Clinical Epidemiology, 5,* 205-217. doi:10.2147/clep.s37071

Chiropractic Library Collaboration. (2012a). *About us*. Retrieved from http://www.chiroindex.org/about

Chiropractic Library Collaboration. (2012b). *Search ICL*. Retrieved from http://www.chiroindex.org/#results

Coates, T., Bax, R., & Coates, A. (2009). Nasal decolonization of *Staphylococcus aureus* with mupirocin: Strengths, weaknesses, and future prospects. *Journal of Antimicrobial Chemotherapy, 64*(1), 9-15. doi:10.1093/jac/dkp159

Cohen, P. R. (2005a). Community-acquired methicillin-resistant *Staphylococcus aureus*: Skin infection presenting as an axillary abscess with cellulitis in a college athlete. *Skinmed, 4*(2), 115-118. doi:10.1111/j.1540-9740.2005.03866.x

Cohen, P. R. (2005b). Cutaneous community-acquired methicillin-resistant *Staphylococcus aureus* infection in participants of athletic activities. *Southern Medical Journal, 98*(6), 596-602. doi:10.1097/01.SMJ.0000163302.72469.28

Colley, F., & Haas, M. (1994). Attitudes on immunization: A survey of American chiropractors [abstract]. *Journal of Manipulative and Physiologic Therapeutics, 17*(9), 584-590. Retrieved from http://www.jmptonline.org

Como-Sabetti, K. J., Harriman, K. H., Fridkin, S. K., Jawahir, S. L., & Lynfield, R. (2011). Risk factors for community-associated *Staphylococcus aureus* infections: Results from parallel studies including methicillin-resistant and methicillin-sensitive *S. aureus* compared to uninfected controls. *Epidemiology and Infection, 139,* 419-429. doi:10.1017/S0950268810001111

Cook, H. A., Furuya, E. Y., Larson, E., Vasquez, G., & Lowy, F. D. (2007). Heterosexual transmission of community-associated methicillin-resistant *Staphylococcus aureus*. *Clinical Infectious Diseases, 44*, 410-413. doi:10.1086/510681

The Council on Chiropractic Education. (2012a). *Accredited Doctor of Chiropractic programs/institutions.* Retrieved from http://www.cce-usa.org/Accredited_ Doctor_Chiro.html

The Council on Chiropractic Education. (2012b). *CCE accreditation standards: Principles, processes, & requirements for accreditation.* Retrieved from http://www.cce-usa.org/uploads/2012-01_CCE_STANDARDS.pdf

Creamer, E., Dorrian, S., Dolan, A., Sherlock, O., Fitzgerald-Hughes, D., Thomas, T., ... Humphreys, H. (2010). When are the hands of healthcare workers positive for methicillin-resistant *Staphylococcus aureus*? *Journal of Hospital Infection, 75*(2), 107-111. doi:10.1016/j.jhin.2009.12.005

Creech, C. B., Saye, E., McKenna, B. D., Johnson, B. G., Jimenez, N., Talbot, T. R., … Edwards, K. M. (2010). One-year surveillance of methicillin-resistant *Staphylococcus aureus* nasal colonization and skin and soft tissue infections in collegiate athletes. *Archives of Pediatrics & Adolescent Medicine, 164*(7), 615-620. doi:10.1001/archpediatrics.2010.93

Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches* (3rd ed.). Thousand Oaks, CA: Sage Publications, Inc.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16*(3), 297-334. doi:10.1007/bf02310555

Crum, N. F., Lee, R. U., Thornton, S. A., Stine, O. C., Wallace, M. R., Barrozo, C., ... Russell, K. L. (2006). Fifteen-year study of the changing epidemiology of methicillin-resistant *Staphylococcus aureus*. *American Journal of Medicine, 119*(11), 943-951. doi:10.1016/j.amjmed.2006.01.004

Crutzen, R., & Göritz, A. S. (2011). Does social desirability compromise self-reports of physical activity in web-based research? *Journal of Behavioral Nutrition and*

Physical Activity, 8(31), e1-e4. doi:10.1186/1479-5868-8-31

D'Agata, E. M., Horn, M. A., Ruan, S., Webb, G. F., & Wares, J. R. (2012). Efficacy of infection control interventions in reducing spread of multidrug-resistant organisms in the hospital setting. *PLoS One, 7*(2), e30170. doi:10.1371/journal.pone.0030170

Dantes, R. Mu, Y., Belflower, R., Aragon, D., Dumyati, G., Harrison, L. H. Lessa, F. C., ... Fridkin, S. (2013). National burden of invasive methicillin-resistant *Staphylococcus aureus* infections, United States, 2011. *JAMA Internal Medicine, 173*(21), 1970-1978. doi:10.1001/jamainternmed.2013.10423

Daum, R. S., Ito, T., Hiramatsu, K., Hussain, F., Mongkolrattanothai, K., Jamklang, M., & Boyle-Vavra, S. (2002). A novel methicillin-resistance cassette in community-acquired methicillin-resistant *Staphylococcus aureus* isolates of diverse genetic backgrounds. *Journal of Infectious Diseases, 186*(9), 1344-1347. doi:10.1086/344326

David, M. Z., & Daum, R. S. (2010). Community-associated methicillin-resistant *Staphylococcus aureus*: Epidemiology and clinical consequences of an emerging epidemic. *Clinical Microbiology Reviews, 23*(3), 616-687. doi:10.1128/CMR.00081-09

Davis, M. A., Smith, M., & Weeks, W.B. (2012). Influenza vaccination among chiropractic patients and other users of complementary and alternative medicine: Are chiropractic patients really different? *Preventive Medicine, 54*(1)*, 5-8.* doi:10.1016/j.ypmed.2011.01.007

Davis, M. A., Sriovich, B. E., & Weeks, W. B. (2009). Utilization and expenditures on chiropractic care in the United States from 1997 to 2006. *Health Services Research*, *45*(3), 748-761. doi:10.1111/j.1475-6773.2009.01067.x

Dean, A. G., Sullivan, K. M., & Soe, M. M. (2014). *OpenEpi: Open source epidemiologic statistics for public health–Version 3.03*. Retrieved from http://www.openepi.com/Menu/OE_Menu.htm

De Giusti, M., Marinelli, L., Aurigemma, C., Tufi, D., Mannocci, A., Solimini, A. G., ... La Torre, G. (2013). Prevalence of *Staphylococcus aureus* colonization and antibiotic susceptibility: A survey among biomedical students. *Public Health, 127*(4), 392-394. doi:10.1016/j.puhe.2012.09.008

DeLeo, F. R., Otto, M., Kreiswirth, B. N., & Chambers, H. F. (2010). Community-associated methicillin-resistant *Staphylococcus aureus*. *Lancet, 375*, 1557-1568. doi:10.1016/s0140-6736(09)61999-1

Department of Veterans Affairs (2014). *Requirements for the protection of human subjects in research.* Retrieved from http://va.gov/vhapublications/ViewPublication.asp?pub_ID=3052

Diep, B. A., Chambers, H. F., Graber, C. J., Szumowski, J. D., Miller, L. G., Han, L. L., … Perdreau-Remington, F. (2008). Emergence of multidrug-resistant, community-associated, methicillin-resistant *Staphylococcus aureus* clone USA300 in men who have sex with men. *Annals of Internal Medicine, 148*(4), 249-257. doi:10.7326/0003-4819-148-4-200802190-00204

Downee, L., Tyree, P. T., Huebner, C. E., & Lafferty, W. E. (2009). Pediatric vaccination and vaccine-preventable disease acquisition: Associations with care by complementary and alternative medicine providers. *Maternal and Child Health Journal, 14*(6), 922-930. doi:10.1007/s10995-009-0519-5

Du, J., Chen, C., Ding, B., Tu, J., Qin, Z., Parsons, C., … Yu, F. (2011). Molecular characterization and antimicrobial susceptibility of nasal *Staphylococcus aureus* isolates from a Chinese medical college campus. *PLoS One, 6*(11), e27328. doi:10.1371/journal.pone.0027328

Elias, A. F., Chaussee, M. S., McDowell, E. J., & Huntington, M. K. (2010). Community-based intervention to manage and outbreak of MRSA skin infections in a county jail. *Journal of Correctional Health Care, 16*(3), 205-215. doi:10.1177/1078345810366679

Ellis, M. W., Griffith, M. E., Dooley, D. P., McLean, J. C., Jorgensen, J. H., Patterson, J. E., ... Hospenthal, D. R. (2007). Targeted intranasal mupirocin to prevent colonization and infection by community-associated methicillin-resistant *Staphylococcus aureus* strains in soldiers: A cluster randomized controlled trial. *Antimicrobial Agents and Chemotherapy, 51*(10), 3591-3598. doi:10/1128/AAC.01086-06

Ellis, M. W., Griffith, M. E., Jorgensen, J. H., Hospenthal, D. R., Mende, K., & Patterson, D. R. (2009). Presence and molecular epidemiology of virulence factors in methicillin-resistant *Staphylococcus aureus* strains colonizing and infecting soldiers. *Journal of Clinical Microbiology, 47*(4), 940-945. doi:10.1128/JCM.02352-08

Ellis, M. W., Hospenthal, D. R., Dooley, D. P., Gray, P. J., & Murray, C. K. (2004). Natural history of community-acquired methicillin-resistant *Staphylococcus aureus* colonization and infection in soldiers. *Clinical Infectious Diseases, 39*, 971-978. doi:10.1086/423965

Ellis, M. W., Schlett, C. D., Millar, E. V., Wilkins, K. J., Crawford, K. B., Morrison-Rodriguez, S. M., … Tribble, D. R. (2014). Hygiene strategies to prevent methicillin-resistant *Staphylococcus aureus* skin and soft tissue infections: A cluster-randomized controlled trial among high-risk military trainees. *Clinical Infectious Diseases, 58*(11), 1540-1548. doi:10.1093/cid/ciu166

Evans, M. W., & Breshears, J. (2007). Attitudes and behaviors of chiropractic college students on hand sanitizing and treatment table disinfection: Results of initial survey and focus group. *Journal of the American Chiropractic Association, 44*(4), 13-23. Retrieved from http://www.acatoday.org

Evans, M. W., Breshears, J., Campbell, A., Husbands, C., & Rupert, R. (2007). Assessment and risk reduction of infectious pathogens on chiropractic treatment tables. *Chiropractic & Osteopathy, 15(*8), e1-5. doi:10.1186/1746-1340-15-8

Evans, M. W., Campbell, A., Husbands, C., Breshears, J., Ndetan, H., & Rupert, R. (2008). Cloth-covered chiropractic treatment tables as a source of allergens and pathogenic microbes. *Journal of Chiropractic Medicine, 7*(1), 34-38. doi:10.1016/j.jcme.2007.10.003

Evans, M. W., Ramcharan, M., Floyd, R., Globe, G., Ndetan, H., Williams, R., & Ivie, R. (2009). A proposed protocol for hand and table sanitizing in chiropractic clinics and education institutions. *Journal of Chiropractic Medicine, 8*(1)*,* 38-47. doi:10.1016/j.jcm.2008.09.003

Evans, M. W., Ramcharan, M., Ndetan, H., Floyd, R., Globe, G., Pfefer, M., & Brantingham, J. (2009). Hand hygiene and treatment table sanitizing in chiropractic teaching institutions: Results of an education intervention to increase compliance. *Journal of Manipulative and Physiologic Therapeutics, 32*(6), 469-476. doi:10.1016/j.jmpt.2009.06.007

Fleming, J. B. (1966). Semmelweis commemoration. Puerperal fever: The historical development of its treatment. *Proceedings of the Royal Society of Medicine, 59*(4), 341-345. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/journals/269/

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*, 1967-1974. doi:10.1016/j.jpedsurg.2010.05.009

Freitas, E. A. F., Harris, R. M., Blake, R. K., & Salgado, C. D. (2010). Prevalence of USA300 strain type of methicillin-resistant *Staphylococcus aureus* among patients with nasal colonization identified with active surveillance. *Infection Control and Hospital Epidemiology, 31*(5), 469-475. doi:10.1086/651672

Fritz, S. A., Epplin, E. K., Garbutt, J., & Storch, G. A. (2009). Skin infection in children colonized with community-associated methicillin-resistant *Staphylococcus aureus*. *Journal of Infection, 59*, 394-401. doi:10.1016/j.jinf.2009.09.001

Garza, D., Sungar, G., Johnston, T., Rolston, B., Ferguson, J. D., & Matheson, G.O.

(2009). Ineffectiveness of surveillance to control community-acquired methicillin-resistant *Staphylococcus aureus* in a professional football team. *Clinical Journal of Sports Medicine, 19*(6), 498-501. doi:10.1097/jsm.0b013e3181bd09e0

Gmel, G., & Lokosha, O. (2000). Self-reported frequency of drinking assessed with a closed- or open-ended question format: A split sample study in Switzerland. *Journal of Studies on Alcohol, 61,* 450-454. doi:10.15288/jsa.2000.61.450

Gorwitz, R. J., Kruszon-Moran, D., McAllister, S. K., McQuillan, G., McDougal, L. K., Fosheim, G. E., ... Kuehnert, M. J. (2008). Changes in the prevalence of nasal colonization with *Staphylococcus aureus* in the United States, 2001-2004. *Journal of Infectious Disease, 197*(9), 1226-1234. doi:10.1086/533494

Green, B.N., Johnson, C.D., Egan, J.T., Rosenthal, M., Griffith, E.A., & Evans, M.W. (2012). Methicillin-resistant *Staphylococcus aureus:* An overview for manual therapists. *Journal of Chiropractic Medicine, 11*(1), 64-76. doi:10.1016/j.jcm.2011.12.001

Güçlü, E., Yavuz, T., Tokmak, A., Behçet, M., Karali, E., Oztürk, O., & Egeli, E. (2007). Nasal carriage of pathogenic bacteria in medical students: Effects of clinic exposure on prevalence and antibiotic susceptibility. *European Archives of Otorhinolaryngology*, *264*, 85-88. doi:10.1007/s00405-006-0160-5

Gurieva, T., Bootsma, M.C., & Bonten, M.J. (2012). Successful Veterans Affairs initiative to prevent methicillin-resistant *Staphylococcus aureus* infections revisited [abstract]. *Clinical Infectious Diseases, 54*(11), 1618-1620. doi:10.1093/cid/cis272

Hall, A. J., Bixler, D., & Haddy, L. E. (2009). Multiclonal outbreak of methicillin-resistant *Staphylococcus aureus* infections on a collegiate football team. *Epidemiology and Infection, 137*(1), 85-93. doi:10.1017/S095026880800068X

Hawk, C., Khorsan, R., Lisi, A. J., Ferrance, R. J., & Evans, M. W. (2007). Chiropractic care for nonmusculoskeletal conditions: A systematic review with implications for whole systems research. *Journal of Alternative and Complementary Medicine, 13*(5), 491-512. doi:10.1089/acm.2007.7088

Hawk, C., Long, C. R., Perillo, M., & Boulanger, K. T. (2004). A survey of US chiropractors on clinical preventive services. *Journal of Manipulative and Physiologic Therapeutics, 27*(5), 287-298. doi:10.1016/j.jmpt.2004.04.002

Herold, B. C., Immergluck, L. C., Maranan, M. C., Lauderdale, D. S., Gaskin, R. E., Boyle-Vavra, S., ... Daum, R. S. (1998). Community-acquired methicillin-resistant *Staphylococcus aureus* in children with no identified predisposing risk. *Journal of the American Medical Association, 279*(8), 593-598. doi:10.1001/jama.279.8.593

Higuchi, W., Isobe, H., Iwao, Y., Dohmae, S., Saito, K., Takano, T., ... Yamamoto, T. (2007). Extensive multidrug resistance in of coagulase-negative staphylococci in medical students. *Journal of Infection and Chemotherapy, 13*(1), 63-66. doi:10.1007/s10156-006-0492-5

Hill, A. B. (1965). The environment and disease: Association or causation? *Proceedings of the Royal Society of Medicine, 58*(5), 295-300. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/journals/269/

Hippocrates. (400 BCE). *On airs, waters, and places*. (F. Adams, Trans.). Retrieved from http://classics.mit.edu/Hippocrates/airwatpl.html

Hota, B., Ellenbogen, C., Hayden, M. K., Aroutcheva, A., Rice, T. W., & Weinstein, R. A. (2007). Community-associated methicillin-resistant *Staphylococcus aureus* skin and soft tissue infections at a public hospital: Do public housing and incarceration amplify transmission? *Archives of Internal Medicine, 167*(10), 1026-1033. doi:10.1001/archinte.167.10.1026

Huang, S. S., & Platt, R. (2003). Risk of methicillin-resistant *Staphylococcus aureus* infection after previous infection or colonization. *Clinical Infectious Diseases, 36,* 281-285. doi:10.1086/345955

Injeyan, H. S., Russell, M. L., Verhoef, M. J., & Mutasingwa, D. (2006). Canadian chiropractors' perception of educational preparation to counsel patients on immunization. *Journal of Manipulative and Physiologic Therapeutics, 29*(8), 643-650. doi:10.1016/j.jmpt.2006.08.009

Ishihara, K., Shimokubo, N., Sakagami, A., Ueno, H., Muramatsu, Y., Kudosawa, R., … Tamura, Y. (2010). Occurrence and molecular characteristics of methicillin-resistant *Staphylococcus aureus* and methicillin-resistant *Staphylococcus pseudintermedius* in an academic veterinary hospital. (2010). *Applied and Environmental Microbiology*, *76*(15), 5165-5174. doi:10.1128/AEM.02780-09

Istre, G. R., Kreiss, K., Hopkins, R. S., Healy, G. R., Benziger, M., Canfield, T. M., ... Simmons, R. A. (1982). An outbreak of amoebiasis spread by colonic irrigation at a chiropractic clinic. *England Journal of Medicine, 307*(6), 339-342.

doi:10.1056/nejm198208053070603

Jain, R., Kralovic, S. M., Evans, M. E., Ambrose, M., Simbartl, L. A., Obrosky, D. S., ... Roselle, G. A. (2011). Veterans Affairs initiative to prevent methicillin-resistant *Staphylococcus aureus* infections. *New England Journal of Medicine, 364*(15), 1419-1430. doi:10.1056/NEJMoa1007474

Jevons, M. P. (1961). "Celbenin"-resistant staphylococci. *British Medical Journal, 1*(5219), 124-125. doi:10.1136/bmj.1.5219.124-a

Johnson, R. E. (1970). Extramarital sexual intercourse: A methodological note. *Journal of Marriage and the Family, May,* 279-282. doi:10.2307/350135

Jones, L., Sciamanna, C., & Lehman, E. (2010). Are those who use specific complementary and alternative medicine therapies less likely to be immunized? (2010). *Preventive Medicine, 50*(3), 148-154. doi:10.1016/j.ypmed.2009.12.001

Kaslow, D. C. & Shiver, J. W. (2011). *Clostridium difficile* and methicillin-resistant *Staphylococcus aureus*: Emerging concepts in vaccine development. *Annual review of medicine, 62*, 201-215. doi:10.1146/annurev-med-051109-101544

Kazakova, S. V., Hageman, J. C., Matava, M., Srinivasan, A., Phelan, L., Garfinkel, B., ... Jernigan, D. B. (2005). A clone of methicillin-resistant *Staphylococcus aureus* among professional football players. *New England Journal of Medicine, 352*(5), 468-475. doi:10.1056/nejmoa042859

Keating, K. C., Cleveland, C. S., & Menke, M. (2004). *Chiropractic history: A primer*. Davenport, IA: Association for the History of Chiropractic.

Khawcharoenporn, T., Tice, A. D., Grandinetti, A., & Chow, D. (2010). Risk factors for community-associated methicillin-resistant *Staphylococcus aureus* cellulitis–and the value of recognition. *Hawai'i Medical Journal, 69*(10), 232-236. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/journals/1473/

Kim, O. S., Yim, J. E., & Jeon, M. (2015). Rates of *Staphylococcus aureus* and methicillin-resistant *Staphylococcus aureus* nasal carriage infections among nursing students. *International Journal of Bio-science and Bio-technology, 7*(5), 21-32. doi:10.14257/ijbsbt.2015.7.5.3

King, M. D., Humphrey, B. J., Wang, Y. F., Kourbatova, E. V., Ray, S. M., & Blumberg, H. M. (2006). Emergence of community-acquired methicillin-resistant *Staphylococcus aureus* USA 300 clone as the predominant cause of skin and soft-tissue infections. *Annals of Internal Medicine, 144*(5), 309-317. doi:10.7326/0003-4819-144-5-200603070-00005

Kingdom, J. C., Joyce, S. M., Bradley, F. L., Jauch, W., Falkiner, F. R., & Keane, C. T. (1983). Staphylococcal nasal carriage in medical students with varying clinical exposure. *Journal Of Hospital Infection, 4*(1), 75-79. doi:10.1016/0195-6701(83)90069-5

Klevens, R. M., Morrison, M. A., Fridkin, S. K., Reingold, A., Petit, S., Gershman, K., ... Tenover, F.C. (2006). Community-associated methicillin-resistant *Staphylococcus aureus* and healthcare risk factors. *Emerging Infectious Diseases, 12*(12), 1991-1993. doi:10.3201/eid1212.060505

Klevens, R. M., Morrison, M. A., Nadle, J., Petit, S., Gershman, K., Ray, S., ... Fridkin, S.K. (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

Kuehnert, M. J., Kruszon-Moran, D., Hill, H. A., McQuillan, G., McAllister, S. K., Fosheim, G., … Tenover, F. C. (2006). Prevalence of *Staphylococcus aureus* nasal colonization in the United States, 2001-2002. *Journal of Infectious Diseases, 193*(2), 172-179. doi:10.1086/499632

LaMar, J. E., Carr, R. B., Zinderman, C., & McDonald, K. (2003). Sentinel cases of community-acquired methicillin-resistant *Staphylococcus aureus* onboard a naval ship. *Military Medicine, 168*(2), 135-138. Retrieved from http://publications. amsus.org

Lameris, M., Schmidt, C., Gleberzon, B., & Ogrady, J. (2013). Attitudes toward vaccination: A cross-sectional survey of students at the Canadian Memorial Chiropractic College [abstract]. *Journal of the Canadian Chiropractic Association,57*(3), 214-220. Retrieved from http://www.chiropractic.ca/jcca-online/

Largent, E. A., Grady, C., Miller, F. G., & Wertheimer, A. (2012). Money, coercion, and undue inducement: Attitudes about payments to research participants. *IRB: Ethics and Human Research, 1*, 1-8. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/ articles/PMC4214066/

Larkin-Thier, S. M., Barber, V. A., Harvey, P., & Livdans-Forret, A. B. (2010). Community-acquired methicillin-resistant *Staphylococcus aureus*: A potential diagnosis for a 16-year-old athlete with knee pain. *Journal of Chiropractic*

Medicine, 9, 32-37. doi:10.1016/j.jcm.2009.12.001

Lawyer, M. H. (1994). HIV and dentistry. *Valparaiso University Law Review, 29*(1), 297-359. Retrieved from http://scholar.valpo.edu/vulr/

Lederer, Jr., J. W., Best, D. & Hendrix, V. (2009). A comprehensive hand hygiene approach to reducing MRSA health care-associated infections [Abstract]. *Joint Commission Journal on Quality and Patient Safety, 35*(4), 180-185. Retrieved from http://www.jcrinc.com/the-joint-commission-journal-on-quality-and-patient-safety/

Lee, N. E., Taylor, M. M., Bancroft, E., Ruane, P. J., Morgan, M., McCoy, L., & Simon, P. A. (2005). Risk factors for community-associated methicillin-resistant *Staphylococcus aureus* skin infections among HIV-positive men who have sex with men. *Clinical Infectious Diseases, 40*, 1529-1534. doi:10.1086/429827

Lindenmayer, J. M., Schoenfeld, S., O'Grady, R., & Carney, J. K. (1998). Methicillin-resistant *Staphylococcus aureus* in a high school wrestling team and the surrounding community. *Archives of Internal Medicine, 158*(8), 895-899. doi:10.1001/archinte.158.8.895

Lloyd-Smith, E., Hull, M. W., Tyndall, M. W., Zhang, R., Wood, E., Montaner, J. S., ... Romney, M.G. (2010). Community-associated methicillin-resistant *Staphylococcus aureus* is prevalent in wounds of community-based injection drug users. *Epidemiology and Infection, 138*(5), 713-720. doi:19.1017/S0950268810000464

Lowy, F. D. (2013). Methicillin-resistant *Staphylococcus aureus*: Where is it coming from and where is it going? *JAMA Internal Medicine, 173*(21), 1978-1979. doi:10.1001/jamainternmed.2013.8277

Lucero, C. A., Hageman, J., Zell, E. R., Bulens, J., Nadle, J., Petit, S., ... Fridkin, S. K. (2009). Evaluating the potential public health impact of a *Staphylococcus aureus* vaccine through use of population-based surveillance for invasive methicillin-resistant *S. aureus* disease in the United States. *Vaccine, 27*(37), 5061-5068. doi:10.1016/j.vaccine.2009.06.055

Lum, T., Picardo, K., Westbay, T., Barnello, A., Fine, L., & Lavigne, J. (2014). Student self-screening for methicillin-resistant *Staphylococcus aureus* (MRSA) nasal colonization in hand hygiene education. *American Journal of Pharmacy Education, 78*(7), e1-e7. doi:10.5688%2Fajpe787138

Lund Research Ltd. (2013a). *Binomial logistic regression in SPSS*. Retrieved from https://statistics.laerd.com/premium/blr/logistic-regression-in-spss.php

Lund Research Ltd. (2013b). *Chi-square test for association in SPSS*. Retrieved from https://statistics.laerd.com/premium/cstfa/chi-square-test-in-spss.php

Lund Research Ltd. (2013c). *Loglinear analysis in SPSS*. Retrieved from https://statistics.laerd.com/premium/la/loglinear-in-spss.php

Lund Research Ltd. (2013d). *Simple linear regression in SPSS*. Retrieved from https://statistics.laerd.com/premium/lr/linear-regression-in-spss.php

Ma, X. X., Sun, D. D., Wang, S., Wang, M. L., Li, M., Shang, H., ... Luo, E. J. (2011). Nasal carriage of methicillin-resistant *Staphylococcus aureus* among preclinical medical students: Epidemiologic and molecular characteristics of methicillin-resistant *S. aureus* clones. *Diagnostic Microbiology and Infectious Disease, 70*(1), 22-30. doi:10.1016/j.diagmicrobio.2010.12.004

Macario, E., Daum, R. S., Eells, S. J., & Miller, L. G. (2010). Using cognitive interviews to refine a household contacts survey on the epidemiology of community-associated methicillin resistant *Staphylococcus aureus*. *Journal of Infection Prevention, 11*(44), 44-48. doi:10.1177/1757177409360483

Malachowa, N., Kobayashi, S. D., & DeLeo, F. R. (2012). Community-associated methicillin-resistant *Staphylococcus aureus* and athletes. *Physician and Sportsmedicine, 40*(2), 13-21. doi:10.3810/psm.2012.05.1960

Malcolm, B. (2011). The rise of methicillin-resistant *Staphylococcus aureus* in correctional populations. *Journal of Correctional Health Care, 17*(3), 254-265. doi:0.1177/1078345811401363

Maree, C. L., Eells, S. J., Tan, J., Bancroft, E. A., Malek, M., Harawa, N. T., ... Miller, L. G. (2010). Risk factors for infection and colonization with community-associated methicillin-resistant *Staphylococcus aureus* in the Los Angeles County jail: A case-control study. *Clinical Infectious Diseases, 51*(11), 1248-1257. doi:10.1086/657067

McAllister, L., Gaynes, R. P., Rimland, D., & McGowan, J. E. (2010). Hospitalization earlier than 1 year prior to admission as an additional risk factor for methicillin-resistant *Staphylococcus aureus* colonization. *Infection Control and Hospital Epidemiology, 31*(5), 538-540. doi:10.1086/652451

McCoy, M. (2009). Chiropractic part of swine flu prevention program in children

[Editorial]. *Research Update.* Retrieved from http://researchupdate.mccoypress.net/2009/09/08/chiropractic-part-of-swine-flu-prevention-program-in-children.aspx

McCoy Press. (2013). *Chiropractic enrollment remains flat.* Retrieved from http://chiropractic.prosepoint.net/76525

McDougal, L. K., Fosheim, G. E., Nicholson, A., Bulens, S. N., Limbago, B. M., Shearer, J. E. S., ... Patel, J. B. (2010). Emergence of resistance among USA300 methicillin-resistant *Staphylococcus aureus* isolates causing invasive disease in the United States. *Antimicrobial Agents and Chemotherapy, 54*(9), 3804-3811. doi:10.1128/AAC.00351-10

McMurty, A., Wilson, K., Clarkin, C., Walji, R., Kilian, B. C., Kilian, C. C., ... Busse, J. W. (2015). The development of vaccination perspectives among chiropractic, naturopathic and medical students: A case study of professional enculturation. *Advances in Health Science Education, 20*(5), 1291-1302. doi:10.1007/s10459-015-9602-4

Medd, E. A., & Russell, M. L. (2009). Personal and professional immunization behavior among Alberta chiropractors: A secondary analysis of cross-sectional survey data. *Journal of Manipulative and Physiologic Therapeutics, 32*(6), 448-452. doi:10.1016/j.jmpt.2009.06.006

Meddles-Torres, C., Hu, S., & Jurgens, C. (2013). Changes in prescriptive practices in skin and soft tissue infections associated with the increased occurrence of community acquired methicillin resistant *Staphylococcus aureus*. *Journal of*

Infection and Public Health, 6(6), 423-430. doi:http://dx.doi.org/10.1016/j.jiph.2013.04.010

Meeker, W. C., & Haldeman, S. (2002). Chiropractic: A profession at the crossroads of mainstream and alternative medicine. *Annals of Internal Medicine, 136*(3), 216-227. doi:10.7326/0003-4819-136-3-200202050-00010

Mera, R. M., Suaya, J. A., Amrine-Madsen, H., Hogea, C. S., Miller, L. A., Lu, E. P., ... Acosta, C.J. (2011). Increasing role of *Staphylococcus aureus* and community-acquired methicillin-resistant *Staphylococcus aureus* infections in the United States: A 10-year trend of replacement and expansion. *Microbial Drug Resistance, 17*(2), 321-328. doi:10.1089/mdr.2010.0193

Merrill, R. M. (2013). *Introduction to epidemiology* (6th ed.). Burlington, MA: Jones & Bartlett Learning.

Miller, L. G., & Diep, B. A. (2008). Colonization, fomites, and virulence: Rethinking the pathogenesis of community-associated methicillin-resistant *Staphylococcus aureus* infections. *Clinical Infectious Diseases, 46*, 752-760. doi:10.1086/526773

Miller, L. G., Eells, S. J., Taylor, A. R., David, M. Z., Ortiz, N., Zychowski, D., ... Daum, R. S. (2012). *Staphylococcus aureus* colonization among household contacts of patients with skin infections: Risk factors, strain discordance, and complex ecology. *Clinical Infectious Diseases, 54*(11), 1523-1535. doi:10.1093/cid/cis213

Miller, L. G., Perdreau-Remington, F., Bayer, A. S., Diep, B., Tan, N., Bharadwa, K., ... Spellberg, B. (2007). Clinical and epidemiologic characteristics cannot distinguish community-associated methicillin-resistant *Staphylococcus aureus* infection from methicillin-susceptible *S. aureus* infection: A prospective investigation. *Clinical Infectious Diseases, 44*, 471-482. doi:10.1086/511033

Miller, M., Cook, H.A., Furuya, E. Y., Bhat, M., Lee, M.-H., Vavagiakis, P., ... Lowy, F. D. (2009). *Staphylococcus aureus* in the community: Colonization versus infection. *PLoS ONE, 4*(8), e6708. doi:10.1371/journal.pone.0006708

Miramonti, C., Rinkle, J. A., Iden, S., Lincoln, J., Huffman, G., Riddell, E., & Kozak, M. A. (2013). The prevalence of methicillin-resistant *Staphylococcus aureus* among out-of-hospital care providers and emergency medical technician students. *Prehospital Emergency Care, 17*(1), 73-7. doi:10.3109/10903127.2012.717169

Moran, G. J., Krishnadasan, A., Gorwitz, R. J., Fosheim, G. E., McDougal, L. K., Carey, R. B., Talan, D. A. (2006). Methicillin-resistant *S. aureus* infections among patients in the emergency department. *New England Journal of Medicine, 355*(7), 666-674. doi:10.1056/NEJMoa055356

Morita, J. E., Fujioka, R. S., Tice, A. D., Berestecky, J., Sato, D., Seifreid, S. E., & Katz, A. R. (2007). Survey of methicillin-resistant *Staphylococcus aureus* (MRSA) carriage in healthy college students, Hawai'i. *Hawaii Medical Journal, 66*(6), 213-215. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/journals/1473/

Morris, D. O., Lautenbach, E., Zaoutis, T., Leckerman, K., Edelstein, P. H., & Rankin, S. C. (2012). Potential for pet animals to harbour methicillin-resistant *Staphylococcus aureus* when residing with human MRSA patients. *Zoonoses and Public Health, 59*(4), 286-293. doi:10.1111/j.1863-2378.2011.01448.x

Murphy, D. R., Schneider, M. J., Seaman, D. R., Perle, S. M., & Nelson, C. F. (2008).

How can chiropractic become a respected mainstream profession? The example of podiatry. *Chiropractic and Osteopathy, 16*(10), e1-e9. doi:10.1186/1746-1340-16-10

Naimi, T. S., Kathleen, H. L., Como-Sabetti, K., Borchardt, S. M., Boxrud, D. J., Etienne, J., ... Lynfield, R. (2003). Comparison of community- and health care-associated methicillin-resistant *Staphylococcus aureus* infection. *Journal of the American Medical Association, 290*(22), 2976-2984. doi:10.1001/jama.290.22.2976

National Board of Chiropractic Examiners. (2010). *Practice analysis of chiropractic: A project report, survey analysis, and summary of practice of chiropractic within the United States*. Greeley, CO: National Board of Chiropractic Examiners.

National Library of Medicine. (2011). *Fact sheet: Medical subject headings (MeSH®).* Retrieved from http://www.nlm.nih.gov/pubs/factsheets/mesh.html

National Library of Medicine. (2012). *MeSH heading: Methicillin-resistant Staphylococcus aureus.* Retrieved from http://www.nlm.nih.gov/cgi/mesh/2012/MB_cgi?mode=&term=Methicillin-Resistant+Staphylococcus+aureus&field=entry

Nerby, J. M., Gorwitz, R., Lesher, L., Juni, B., Jawahir, S., Lynfield, R., & Harriman, K. (2011). Risk factors for household transmission of community-associated methicillin-resistant *Staphylococcus aureus*. *Pediatric Infectious Disease Journal, 30*(11), 927-932. doi:10.1097/INF.0b013e31822256c3

New York Chiropractic College. (2010). *Doctor of Chiropractic Curriculum.* Retrieved from http://www.nycc.edu/webdocs/registrar/DC_Curriculum.pdf

New York Chiropractic Council. (2010). *New Directions: Official Journal of the New York Chiropractic Council*, *Spring*. New York, NY: New York Chiropractic Council.

Nguyen, D. M. Mascola, L., & Bancroft, E. (2005). Recurring methicillin-resistant *Staphylococcus aureus* infections in a football team. *Emerging Infectious Diseases, 11*(4), 526-532. doi:10.1097/00132981-200503000-00032

Nourbakhsh, A., Papafragkou, S., Dever, L. L., Capo, J., & Tan, V. (2010). Stratification of the risk factors of community-acquired methicillin-resistant *Staphylococcus aureus* hand infection. *Journal of Hand Surgery, 35*(7), 1135-1141. doi:10.1016/j/jhsa.2010.03.039

O'Hara, F. P., Guex, N., Word, J. M., Miller, L. A., Becker, J. A., Walsh, S. L., ... Amrine-Madsen, H. (2008). A geographic variant of the *Staphylococcus aureus* Panton-Valentine leukocidin toxin and the origin of community-associated methicillin-resistant *S. aureus* USA300. *Journal of Infectious Diseases, 197*(2), 187-194. doi:10.1086/524684

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

Oller, A. R., Province, L., & Curless, B. (2010). *Staphylococcus aureus* recovery from environmental and human locations in 2 collegiate athletic teams. *Journal of Athletic Training, 45(3), 222-229.* doi:10.4085/1062-6050-45.3.222

Page, S. A., Russell, M. L., Verhoef, M. J., & Injeyan, H. S. (2006). Immunization and the chiropractor-patient interaction: A western Canadian study. *Journal of Manipulative and Physiologic Therapeutics, 29*(2), 156-161. doi:10.1016/j.jmpt.2005.12.005

Parchman, M. L., & Munoz, A. (2009). Risk factors for methicillin-resistant *Staphylococcus aureus* skin and soft tissue infections presenting in primary care: A South Texas Ambulatory Research Network (STARNet) study. *Journal of the American Board of Family Medicine, 22*(4), 375-379. doi:10.3122/jabfm.2009.04.090003

Penn State Eberly College of Science. (2015). *12.4 - Detecting multicollinearity using variance inflation factors*. Retrieved from https://onlinecourses.science.psu. edu/stat501/node/347

Peterson, D. H., & Bergmann, T. F. (2002). *Chiropractic technique: Principles and procedures* (2nd ed.). St. Louis, MO: Mosby.

Peterson, D. H., & Wiese, G. (1995). *Chiropractic: An illustrated history*. St. Louis, MO: Mosby.

Piechowicz, L., Garbacz, K., Wiśniewska, K., & Dąbrowska-Szponar, M. (2011). Screening of *Staphylococcus aureus* nasal strains isolated from medical students for toxin genes. *Folia Microbiologica, 56*(3), 225-229. doi:10.1007/s12223-011-0041-1

Pokras, R. S., & Iler, L. L. (1990). Bacterial load on the chiropractic adjusting table. *Journal of the Australian Chiropractors' Association, 20*(1), 85-89. Retrieved from http://www.chiroindex.org/#results

Popovich, K., Hota, B., Rice, T., Aroutcheva, A., & Weinstein, R. A. (2007). Phenotypic prediction rule for community-associated methicillin-resistant *Staphylococcus aureus*. *Journal of Clinical Microbiology, 45*(7), 2293-2295. doi:10.1128/JCM.00044-07

Porta, M. (Ed.) (2008). *A dictionary of epidemiology* (5th ed.). Oxford, UK: Oxford University Press.

Prates, K. A., Torres, A. M., Garcia, L. B., Ogatta, S. F. Y., Cardoso, C. L., & Tognim, M. C. B. (2010). Nasal carriage of methicillin-resistant *Staphylococcus aureus* in university students. *Brazilian Journal of Infectious Diseases, 14*(3), 316-318. Retrieved from http://www.scielo.br/scielo.php?script=sci_serial&pid=1413-8670&lng=en&nrm=iso

Puhl, A. A., Reinhart, C. J., Puhl, N. J., Sellinger, L. B., & Injeyan, H. S. (2011). An investigation of bacterial contamination on treatment table surfaces of chiropractors in private practice and attitudes and practices concerning table disinfection. *American Journal of Infection Control, 39*(1), 56-63. doi:10.1016/j.ajic.2010.05.029

Rackham, D. M., Ray, S. M., Franks, A. S., Bielak, K. M., & Pinn, T. M. (2010). Community-associated methicillin-resistant *Staphylococcus aureus* nasal carriage in a college student athlete population. *Clinical Journal of Sport Medicine, 20*(3), 185-188. doi:10.1097/JSM.0b013e3181dba80d

Rafee, Y., Abdel-Haq, N., Asmar, B., Salimnia, T., Pharm, C. V., Pharm, M. J. R., &

Amjad, M. (2012). Increased prevalence of methicillin-resistant *Staphylococcus aureus* nasal colonization in household contacts of children with community acquired disease. *BMC Infectious Disease, 12*(45), e1-e7. doi:10.1186/1471-2334-12-45

Ray, G. T., Suaya, J. A., & Baxter, R. (2013). Incidence, microbiology and patient characteristics of skin and soft-tissue infections in a U. S. population: A retrospective population-based study. *BMC Infectious Diseases, 13*(252), e1-11. doi:10.1186/1471-2334-13-252

Regev-Yochay, G., Dagan, R., Raz., M., Carmeli, Y., Shainberg, B., Derazne, E., ... Rubinstein, E. (2004). Association between carriage of *Streptococcus pneumonia* and *Staphylococcus aureus* in children. *Journal of the American Medical Association, 292*(6), 716-702. doi:10.1001/jama.292.6.716

Renushri, A., Nagaraj, S., & Krishnamurthy, V. (2011). Inducible clindamycin resistance in *Staphylococcus aureus* isolated from nursing and pharmacy students. *Journal of Laboratory Physicians, 3*(2), 89-92. doi:10.4103/0974-2727.86840

Ridgway, J. P., Peterson, L. R., Brown, E. C., Du, H., Hebert, C., Thomson, Jr., R. B., ... Robicsek, A. (2013). Clinical significance of methicillin-resistant *Staphylococcus aureus* colonization on hospital admission: One-year infection risk. *PLoS ONE, 8*(11), e79716. doi:10.1371/journal.pone.0079716

Rim, J. Y., & Bacon, A. E., III. (2007). Prevalence of community-acquired methicillin-resistant *Staphylococcus aureus* colonization in a random sample of healthy individuals. *Infection Control and Hospital Epidemiology, 28*(9), 1044-1046.

doi:10.1086/519934

Rohde, R. E., Denham, R., & Brannon, A. (2009). Methicillin-resistant *Staphylococcus aureus*: Carriage rates and characteristics of students in a Texas university. *Clinical Laboratory Science, 22*(3), 176-184. Retrieved from http://www.ascls.org

Rohde, R. E., Patterson, T., Covington, B., Vásquez, B. E., Redwine, G., & Carranco, E. (2014). Staphylococcus, not MRSA? A final report of carriage and conversion rates in nursing students. *Clinical Laboratory Science, 27*(1), 21-31. Retrieved from http://www.ascls.org

Rohrer, J. E., Grover, M. L., & Moats, C. C. (2013). Utilising the epidemiologic triad in analysing quality improvement data: Antibiotic use for respiratory infections as a case example. *Quality in Primary Care, 21*, 165-170. Retrieved from http://primarycare.imedpub.com

Romano, R., Lu, D., & Holtom, P. (2006). Outbreak of community-acquired methicillin-resistant *Staphylococcus aureus* skin infections among a collegiate football team. *Journal of Athletic Training, 41*(2), 141-145. Retrieved from http://www.ncbi. nlm.nih.gov/pmc/articles/PMC1472644/

Rose, K. A., & Ayad. S. (2008). Factors associated with changes in knowledge and attitude towards public health concepts among chiropractic college students enrolled in a community health class. *Journal of Chiropractic Education, 22*(2), 127-137. doi:10.7899/1042-5055-22.2.127

Russell, M. L., Injeyan, H. S., Verhoef, M. J., & Eliasziw, M. (2004). Beliefs and behaviours: Understanding chiropractors and immunization. *Vaccine, 23*(3), 372-

379. doi:10.1016/j.vaccine.2004.05.027

Russell, M. L., Verhoef, M. J., & Injeyan, H. S. (2005). Are chiropractors interested in participating in immunization awareness and promotion activities? *Canadian Journal of Public Health, 96*(3), 194-196. Retrieved from http://www.cpha.ca/en/cjph.aspx

Salgado, C. D., Farr, B. M., & Calfee, D. P. (2003). Community-acquired methicillin-resistant *Staphylococcus aureus:* A meta-analysis of prevalence and risk factors. *Clinical Infectious Diseases, 36*, 131-135. doi:10.1086/345436

Saravolatz, L. D., Pohlod, D. J., & Arking, L. M. (1982). Community-acquired methicillin-resistant *Staphylococcus aureus* infections: A new source for nosocomial outbreaks. *Annals of Internal Medicine, 97*(3), 325-329. doi:10.7326/0003-4819-97-3-325

Scheithauer, S., Oberröhrmann, A., Haefner, J., Kopp, R., Schürholz, T., Schwanz, T., ... Lemmen, S. W. (2010). Compliance with hand hygiene in patients with meticillin-resistant *Staphylococcus aureus* and extended spectrum **β**-lactamase-producing enterobacteria. *Journal of Hospital Infection, 76*(4), 320-323. doi:10.1016/j.jhin.2010.07.012

Schiavo, R. (2007). *Health communication: From theory to practice*. San Francisco, CA: Jossey-Bass.

Schmidt, K., & Ernst, E. (2003). MMR vaccination advice over the internet. *Vaccine, 21*(11-12), 1044-1047. doi:10.1016/s0264-410x(02)00628-x

Schwartz, M. D. (2011). Nasal carriage of *Staphylococcus aureus* in physician assistant students: Initial prevalence and transmission during clinical rotations. *Journal of Physician Assistant Education, 22*(2), 30-33. doi:10.1097/01367895-201122020-00006

Skov, R., Christiansen, K., Dancer, S. J., Daum, R. S., Dryden, M., Huang, Y.-C., & Lowy, F. D. (2012). Update on the prevention and control of community acquired meticillin-resistant *Staphylococcus aureus* (CA-MRSA). *International Journal of Antimicrobial Agents, 39*, 193-200. doi:10.1016/j.ijantimicag.2011.09.029

Slifka, K. J., Nettleman, M. D., Dybas, L., & Stein, G. E. (2009). Is acquisition of methicillin-resistant *Staphylococcus aureus* an occupational hazard for medical students? [Letter to the editor]. *Clinical Infectious Diseases, 49,* 482-483. doi:10.1086/600824

Smith, M., & Davis, M. A. (2011). Immunization status of adult chiropractic patients in analyses of national health interview survey. *Journal of Manipulative and Physiologic Therapeutics, 34*(9), 602-608. doi:10.1016/j.jmpt.2011.09.001

Snow, J. (1855). *On the mode of communication of cholera*. London, UK: John Churchill. Retrieved from http://books.google.com/books?id=-N0_AAAAcAAJ& printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

Stenstrom, R., Grafstein, E., Romney, M., Fahimi, J., Harris, D., Hunte G., … Christenson J. (2009) Prevalence of and risk factors for methicillin-resistant *Staphylococcus aureus* skin and soft tissue infection in a Canadian emergency department. *Canadian Journal of Emergency Medicine, 11*(5), 430-438. Retrieved from http://journals.cambridge.org/action/displayJournal?jid=CEM

Stevens, A. M., Hennessy, T., Baggett, H. C., Bruden, D., Parks, D., & Klejka, J. (2010). Methicillin-resistant *Staphylococcus aureus* carriage and risk factors for skin infections, Southwestern Alaska, USA. *Emerging Infectious Diseases, 16*(3), 797-803. doi:10.3201/eid1605.091851

Stevens, D. L., Bisno, A. L., Chambers, H. F., Dellinger, E. P., Goldstein, E. J. C., Gorbach, S. L., … Wade, J. C. (2014). Practice guidelines for the diagnosis and management of skin and soft tissue infections: 2014 update by the Infectious Disease Society of America. *Clinical Infectious Diseases, 59*(2), e10-e52. doi:10.1093/cid/ciu296

Stokley, S., Cullen, K. A., Kennedy, A., & Bardenheier, B. H. (2008). Adult vaccination coverage levels among users of complementary/alternative medicine–results from the 2002 National Health Interview Survey (NHIS). *BMC Complementary and Alternative Medicine,* doi:10.1186/1472-6882-8-6

Stubbs, E., Pegler, M., Vickery, A., & Harbour, C. (1994). Nasal carriage of *Staphylococcus aureus* in Australian (preclinical and clinical) medical students. *Journal of Hospital Infection, 27*(2), 127-134. doi:10.1016/0195-6701(94)90005-1

Szumowski, J. D., Wener, K. M., Gold, H. S., Wong, M., Venkataraman, L., Runde, C. A., ... Wright, S. B. (2009). Methicillin-resistant *Staphylococcus aureus* colonization, behavioral risk factors, and skin and soft-tissue infection at an ambulatory clinic serving a large population of HIV-infected men who have sex with men. *Clinical Infectious Diseases, 49*(1), 118-121. doi:10.1086/599608

Talan, D. A., Krishnadasan, A., Gorwitz, R. J., Fosheim, G. E., Limbago, B., Albrecht, V., ... EMERGEncy ID Net Study Group. (2011). Comparison of *Staphylococcus aureus* from skin and soft tissue infections in US emergency department patients, 2004 and 2008. *Clinical Infectious Diseases, 53*(2), 144-149. doi:10.1093/cid/cir308

Tenover, F. C., & Goering, R. V. (2009). Methicillin-resistant *Staphylococcus aureus* strain USA300: Origin and epidemiology. *Journal of Antimicrobial Chemotherapy, 64*(3), 441-446. doi:10.1093/jac/dkp241

Tenover, F. C., McDougal, L. K., Goering, R. V., Killgore, G., Projan, S. J., Patel, J. B., & Dunman, P. M. (2006). Characterization of a strain of community-associated methicillin-resistant *Staphylococcus aureus* widely disseminated in the United States. *Journal of Clinical Microbiology, 44*(1), 108-118. doi:10.1128/JCM.44.1.108-118.2006

Top, K. A., Huard, R. C., Fox, Z., Wu, F., Whittier, S., Della-Latta, P., ... Ratner, A. J. (2010). Trends in methicillin-resistant *Staphylococcus aureus* anovaginal colonization in pregnant women in 2005 versus 2009. *Journal of Clinical Microbiology, 48*(10), 3675-3680. doi:10.1128/JCM.01129-10

Tourangeau, R., & Smith, T. W. (1998). Asking sensitive questions: The impact of data collection mode, question format, and question context. *Public Opinion Quarterly, 60*, 275-304. doi:10.1086/297751

Tracy, L. A., Furuno, J. P., Harris, A. D., Singer, M., Langenberg, P., Roghmann, M.-C. (2011). *Staphylococcus aureus* infections in US veterans, Maryland, USA, 1999-

2008. *Emerging Infectious Diseases, 17*(3), 441-448. doi:10.3201/eid1707.100502

Treesirichod, A., Hantagool, S., & Prommalikit, O. (2014). Nasal carriage and antimicrobial susceptibility of *Staphylococcus aureus* among medical students at the HRH Princess Maha Chakri Sirindhorn Medical Center, Thailand: A follow-up study. *Journal of Infection and Public Health, 7*(3), 205-209. doi:10.1016/j.jiph.2013.12.003

Trépanier, P., Tremblay, C., & Ruest, A. (2013). Methicillin-resistant *Staphylococcus aureus* colonization among medical residents. *Canadian Journal of Infectious Disease and Medical Microbiology, 24*(2), e39-e41. Retrieved from http://www.pulsus.com/journals/journalHome.jsp?sCurrPg=journal&jnlKy=3&fold=Home

Uhlemann, A., Knox, J., Miller, M., Hafer, M., Vasquez, G., Ryan, M., ... Lowy, F. D. (2011). The environment as an unrecognized reservoir for community-associated methicillin resistant *Staphylococcus aureus* USA300: A case-control study. *PLoS ONE, 6*(7), e22407. doi:10.1371/journal.pone.0022407

U. S. Department of Education National Center For Education Statistics. (n.d.). *College Navigator.* Retrieved from http://nces.ed.gov/collegenavigator/

Vandenesch, F., Naimi, T., Enright, M. C., Lina, G., Nimmo, G. R., Heffernan, H., ... Etienne, J. (2003). Community-acquired methicillin-resistant *Staphylococcus aureus* carrying Panton-Valentine leukocidin genes: Worldwide emergence. *Emerging Infectious Diseases, 9*(8), 978-984. doi:10.3201/eid0908.030089

Wertheim, H. F. L., van Kleef, M., Vos, M.C., Ott, A., Verbrugh, H. A., & Fokkens, W.

(2006). Nose picking and nasal carriage of *Staphylococcus aureus*. *Infection Control and Hospital Epidemiology, 27*(8), 863-867. doi:10.1086/506401

Wertheim, H. F. L., Vos, M. C., Ott, A., Voss, A., Kluytmans, J. A. J. W., Vandenbroucke-Grauls, C. M. J. E., ... Verbrugh, H. A. (2004). Mupirocin prophylaxis against nosocomial *Staphylococcus aureus* infections in nonsurgical patients: A randomized study. *Annals of Internal Medicine, 140*(6), 419-425. doi:10.7326/0003-4819-140-6-200403160-00007

Wiese, G. (1996). Chiropractic's tension with the germ theory of disease. *Chiropractic History, 16*(1), 72-87. Retrieved from http://www.historyofchiropractic.org/the-journal/

Wolk, D. M., Marx, J. L., Dominguez, L., Driscoll, D., & Schifman, R. B. (2009). Comparison of MRSASelect Agar, CHROMagar methicillin-resistant *Staphylococcus aureus* (MRSA) medium, and Xpert MRSA PCR for detection of MRSA in nares: Diagnostic accuracy for surveillance samples with various bacterial densities. *Journal of Clinical Microbiology, 47*(12), 3933-3936. doi:10.1128/JCM.00601-09

World Health Organization. (2011). Table 1. Summary of WHO position papers– *Recommendations for routine immunization (updated October 2011)*. Retrieved from http://www.who.int/immunization/policy/Immunization_routine_table1.pdf

Wu, R. C., Thorpe, K., Ross, H., Micevski, V., Marquez, C., & Straus, S. E. (2009). Comparing administration of questionnaires via the internet to pen-and-paper in patients with heart failure: Randomized controlled trial. *Journal of Medical*

Internet Research, 11(1). doi:10.2196/jmir.1106

Yang, E. S., Tan, J., Eells, S., Rieg, G., Tagudar, G., & Miller, L. G. (2010). Body site colonization in patients with community-associated methicillin-resistant *Staphylococcus aureus* and other types of *S. aureus* infections. *Clinical Microbiology and Infection, 16*(5), 425-431. doi:10.111/j.1469-0691.2009.02836x

Zakai, S. A. (2015). Prevalence of methicillin-resistant *Staphylococcus aureus* nasal colonization among medical students in Jeddha, Saudi Arabia. *Saudi Medical Journal, 36*(7), 807-812. doi:10.15537/smj.2015.7.11609

Zimmerman, R. S., & Langer, L. M. (1995). Improving estimates of prevalence rates of sensitive behaviors: The randomized lists technique and self-reported honesty. *Journal of Sex Research, 32*(2), 107-117. doi:10.1080/00224499509551781

Zinderman, C. E., Conner, B., Malakooti, M. A., LaMar, J. E., Armstrong, A., & Bohnker, B. K. (2004). Community-acquired methicillin-resistant *Staphylococcus aureus* among military recruits. *Emerging Infectious Diseases, 10*(5), 941-944. doi:10.3201/eid1005.030604

Appendix A: Questionnaires

Two questionnaires are included in this appendix (they appeared as one questionnaire to the respondents). The first is the screening questionnaire, used to determine if the interested participant met the basic inclusion/exclusion criteria and was part of the sampling frame. The second questionnaire is the survey, which was provided with question logic. The screening questionnaire simply verified the same statement on the link in the informed consent clicked to reach the questionnaire: “I consent. I am at least 18 years old and am not older than 64 years old. I am a current chiropractic student. Take me to the survey.”

Screening Questionnaire

These questions verify that you can be in the study. If you can be in the study, you will then see the full questionnaire. Your assistance is greatly appreciated.

Are you currently a chiropractic student (billed chiropractic tuition)?

□YES □NO

Are you age 17 or younger?

□YES □NO

Are you age 65 or older?

□YES □NO

[Link that stated: “Submit screening questionnaire.”]

Question and page logic directed included and excluded participants differently. Students who answered “yes” to any of the questions (except chiropractic student status) were excluded. Students who answered “no” to chiropractic student status were excluded. Excluded participants exited the survey through survey logic and received a “thank you” notification: “Thank you for being willing to participate in this study. Unfortunately, you do not meet the inclusion criteria for answering further questions. Thank you–no further action on your part is needed at this time. If you have any questions, please feel free to contact the researcher.” Included participants were automatically advanced by question and page logic to the survey.

Survey

Thank you for participating in this study. You meet the criteria and can now answer the questionnaire. **Your responses will be completely confidential.**

The researcher is trying to find out if any factors are connected to antibiotic-resistant staph infections in chiropractic students. Your accurate answers to these questions will help show these connections, if any. Your assistance is greatly appreciated.

Please select chiropractic college campus you currently attend.

□[Campus 1]

□[Campus 2]

□[Campus 3] [All U.S. chiropractic college campuses were listed, to mask which campuses participated and which did not.]

□Other _______________

What year and month did you begin classes as a chiropractic student? Select a year and month.

Year:

□2009

□2010

□2011

□2012

□2013

□2014

□2015

□2016

□ UNSURE

Month:

□Jan

□Feb

□Mar

□Apr

□May

□Jun

□Jul

□Aug

□Sep

□Oct

□Nov

□Dec

□ UNSURE

How old are you? **_____ Years**

What is your gender?

□ Male

□ Female

Which of the following best describes your race?

□ American Indian or Alaska Native

□ Asian

□ Black or African American

□ Hispanic or Latino Origin

□ Native Hawaiian or Pacific Islander

□ White or Caucasian

□ Other __________

What country were you born in?

□ United States

□ Other __________

Have you ever served in the military? □Yes □No □Unsure

Have you started treating patients in a college clinic? □Yes □No □Unsure

When using treatment tables in palpation/technique labs or clinics which best describes your current efforts to sanitize the table surface in addition to changing the face-paper?

□I **never** wipe the table with a sanitizing agent

□I **rarely** wipe the table with something to sanitize its surface

□I **occasionally** wipe the table with something to sanitize its surface

□I **frequently** wipe the table with something to sanitize its surface

□I **always** wipe the table with something to sanitize its surface

Regarding your treatment or examination of fellow students or patients, which most appropriately describes your hand sanitizing practices?

□After contact with students/patients, I **never** sanitize my hands

□After contact with students/patients, I **rarely** sanitize my hands

□After contact with students/patients, I **occasionally** sanitize my hands

□After contact with students/patients, I **frequently** sanitize my hands

□After contact with students/patients, I **always** sanitize my hands

Do people share any of the following with you?

Chiropractic or massage therapy lotion, lubricant, or emollient □Yes □No

Patient practice gowns □Yes □No

MRSA refers to antibiotic resistant staph or 'mersa.' **Did you ever in your life have a medically diagnosed MRSA infection of the skin or tissues under the skin *before* starting to attend chiropractic college?**

□Yes □No □Unsure

MRSA refers to antibiotic resistant staph or 'mersa.' **Did you ever have a medically diagnosed MRSA infection of the skin or of the tissues under the skin *after* starting to attend chiropractic college?**

□Yes □No □Unsure

Have you been in correctional facilities or jail? □Yes □No

Have you ever injected drugs into your veins or under your skin? □ Yes □ No

Questionnaire logic then gave participants slightly different final questions depending on their response to the questions about skin infection.

For participants who indicated having a MRSA SSTI prior to starting chiropractic college:

You indicated that you had a diagnosed MRSA infection of the skin or tissue under the skin **before** starting chiropractic college. If you have had more than one of these MRSA infections in your life **before** starting chiropractic college, answer this question relative to the first infection.

Which of the following apply to *this* MRSA infection (check all that apply):

□ surgery within 12 months before infection

□ dialysis within 12 months before infection

□ hospitalization within 12 months before infection

□ residence in a long-term care facility within 12 months before infection

□ central venous catheter within 12 months before infection

□ none of these

□ unsure

For participants who indicated having a MRSA SSTI after starting chiropractic college:

You indicated that you had a diagnosed MRSA infection of the skin or tissue under the skin **after** starting chiropractic college. If you have had more than one of these MRSA infections **after** starting chiropractic college, answer this question relative to the first infection.

Which of the following apply to *this* MRSA infection (check all that apply):

□ surgery within 12 months before infection

□ dialysis within 12 months before infection

□ hospitalization within 12 months before infection

□ residence in a long-term care facility within 12 months before infection

□ central venous catheter within 12 months before infection

□ none of these

□ unsure

For participants who indicated never having a MRSA SSTI:

You indicated that you have never in your life had a diagnosed MRSA infection of the skin or tissue under the skin.

Which of the following apply to you (check all that apply)

□ surgery within the last 12 months

□ dialysis within the last 12 months

□ hospitalization within the last 12 months

□ residence in a long-term care facility within the last 12 months

□ central venous catheter within the last 12 months

□ none of these

□ unsure

[Link that stated: "Continue."]

Thank you for participating in this survey. If you wish, you can allow your name and email address to be transmitted to Giftbit, a secure, electronic, third party fulfillment service that will provide you with a $2 Amazon credit for your participation. This will involve approving the transmission of your name and email address (not your answers– these are always confidential) to Giftbit. [Link to Giftbit's privacy policy.] If you approve it, your $2 Amazon credit will be transmitted to you after all surveys are collected and the study closes, and is good for 3 months from when it is sent. It will be sent to the same email address through which you received this survey.

□ **I would** like the $2 credit. You **may** transmit my name and email to Giftbit.

□ **I would not** like the $2 credit. **Do not** transmit my name and email to Giftbit.

Note: Giftbit has a privacy policy noted above, and has promised to use enterprise-level security and to not use transmitted information for any other purpose than to provide the credit. The researcher is not responsible for changes in Giftbit's privacy policy or breaches of Giftbit's security. In interest of privacy protection, Giftbit will only have names and email addresses of students who approve transmission for purpose of the credit.

[Question logic directed those who wanted the credit to enter their name and email address.]

□ **I would** like the $2 credit. You **may** transmit my name and email to Giftbit.

Name [Comment Box]

Email [Comment Box that required an email address in this format: text@text.txt]

[Link: Submit questionnaire.]

These references appeared on each page of the questionnaires:

Adapted from the survey questionnaire used in "Nasal carriage of inducible dormant and community-associated methicillin-resistant *Staphylococcus aureus* in an ambulatory population of predominantly university students," by G. M. L. Bearman, A. E. Rosato, S. Assanasen, E. A. Kleiner, K. Elam, C. Haner, & R. P. Wenzel, 2010. *International Journal of Infectious Diseases, 14*(supplement 3), e18-e24. The questionnaire was not previously published. Permission to use the questionnaire granted by the author (G. M. L. Bearman, personal communication, May 29, 2014).

Adapted from the survey questionnaire used in "Attitudes and behaviors of chiropractic college students on hand sanitizing and treatment table disinfection: Results of initial survey and focus group," by M. W. Evans & J. Breshears, 2007. *Journal of the American Chiropractic Association, 44*(4), p.21-22. Copyright 2007 by the American Chiropractic Association.

Adapted from the reporting form "*Active Bacterial Core Surveillance (ABCs) report: Emerging Infections Program Network methicillin-resistant* Staphylococcus aureus, *2012*," by Centers for Disease Control and Prevention, 2012. http://www.cdc.gov/abcs/reports-findings/survreports/mrsa12.pdf

Question and page logic notified participants if they left any questions blank. Once each question was answered, the questionnaire could be submitted.

Appendix B: Chiropractic Immunization Beliefs and Behaviors

An area where chiropractic infection control beliefs and behaviors may differ from mainstream infection control practice is relative to immunization. Chiropractors do not provide vaccinations (NBCE, 2010), and MRSA is not currently vaccine-preventable (Kaslow & Shiver, 2011; Lucero et al., 2009). However, many chiropractors believe disease has a spinal origin as described. Immunization attitudes and practices reflect chiropractic attitudes and behaviors relative to mainstream infection control.

The CDC (1999a), American Public Health Association (2000), and World Health Organization (2011) endorse immunization. The ACA has an ambivalent stance (ACA, 2011). Many studies have examined the attitudes and behaviors of chiropractic practitioners, students, faculty, and patients towards immunization (see Table C1). Though immunization is regarded as one of the greatest public health achievements of the 20th century (CDC, 1999a), immunization is unappreciated and even opposed by many chiropractors and chiropractic students. These views can change (Lameris et al., 2013).

Table B1

Attitudes and Behaviors Towards Immunization Within Chiropractic

Source	Methods and population	Results
Colley & Haas, (1994)	Survey mailed to 1% (n=480) of US chiropractors; 37% (n=178) response	36% felt no scientific support for immunization and diseases are safer; 41% felt immunization does not impact infectious disease incidence; 35% felt immunization caused more disease than prevented; 81% felt immunization should not be mandatory.
Busse et al. (2002)	467 of 621 surveyed students (75%) at CMCC	53.3% of students supported immunization, but the proportion of students opposed was larger in more senior students (4.5% of first year vs. 29.4% of fourth year students).
Schmidt & Ernst, (2003)	32% of UK chiropractors (16 respondents) who were sent a fictitious email for information about MMR vaccination for a child	1 recommended the vaccine; 3 indirectly advised for it; 3 advised more information; 5 did not advise; 3 indirectly advised against; 1 suggested getting each vaccine separately. None overtly opposed.

(table continues)

Source	Methods and Population	Results
Hawk et al. (2004)	Survey mailed to faculty and students at 10 US chiropractic colleges, and a sample of US chiropractors. 582 students, 45 faculty, and 496 chiropractors responded.	91% of faculty, 80% of students, and 62% of chiropractors felt that patients needed to be supplied opposing information about immunization as well as supportive information.
Russell et al. (2004)	Survey mailed to all Alberta, Canada chiropractors; 78.2% response (503 respondents)	48.1% felt immunizations are not safe; 19.2% believe they have a negative impact on the immune system; 45.2% believe they are more harmful than beneficial; 25.9% prefer infection to immunization to develop immunity to these diseases
Russell et al. (2005)	Secondary analysis of mailed survey to all Alberta, Canada chiropractors in 2002	36.9% of chiropractors did not desire any involvement in any suggested immunization awareness or promotional activities.
Injeyan et al. (2006)	Secondary analysis of mailed survey to all Alberta, Canada chiropractors in 2002	Chiropractors with additional education about immunization felt prepared to counsel patients; however, their sources of education were more likely to be antivaccination.
Page et al. (2006)	Semistructured interviews of 14 chiropractors in Alberta, Canada (34 attempted, 6 bad addresses, 14 declined)	One chiropractor would provide supportive information about immunization to a patient; others directly or indirectly offered some or all antivaccination information.
Busse et al. (2008)	Restatement of data from Busse et al. (2002), with addition of naturopathy	Not new chiropractic data–though early analysis of themes from new focus groups revealed immunization concerns.
Rose & Ayad, (2008)	Survey of 106/113 (93.8%) U.S. chiropractic students in a community health course	After a proimmunization course, 46.2% of students felt that children should always receive typical vaccinations
Stokley et al. (2008)	2002 National Health Interview Survey of 30,617 complementary and alternative (CAM) using adults relative to influenza, pneumococcal, and hepatitis B vaccines	Adults who used chiropractors had less immunization coverage than adults who used other CAM therapies but not chiropractic. Adult chiropractic users generally had better immunization coverage than adults that used no form of CAM.
Medd & Russell, (2009)	Secondary analysis of mailed survey to all Alberta, Canada chiropractors in 2002–this analysis examined chiropractors with children (n=325)	92.6% had been immunized; 35.7% would not accept immunization again. 27% with only one child (n=63) had not immunized that child at all. Among those with more than one child (n=262), the oldest child was not immunized 34.0% of the time.
Downee et al. (2010)	Claims from Washington insurers (2000-2003) with 11,144 children including their 1st and 2nd birthdays, and 213,884 children aged 1-17 years with ≥ 1 year of coverage	Pediatric use of chiropractors was associated with decreased adherence to recommended vaccination schedules, and an increase in vaccine preventable illness (generally chicken pox), though the increase did not remain significant in multivariable analysis.
Jones et al. (2010)	2007 National Health Interview Survey of 22,777 adults relative to influenza vaccine	Chiropractic patients alone among users of all forms of CAM were less likely to have received influenza vaccination than other adults.
Smith & Davis (2011)	Review of Stokley et al. (2008) and Jones et al. (2010)	Different analysis methodologies led to different findings relative to chiropractic use and immunization coverage in adults.
Davis, M.A. et al. (2012)	2007 National Health Interview Survey of 12,164 adults at high priority for influenza vaccine	Chiropractic users and non-CAM using adults were similarly vaccinated. Non-chiropractic using, CAM using adults were more likely to be vaccinated than non-CAM using adults.
Lameris et al. (2013)[a]	Web-based survey of all CMCC students; 43% response	By class year, 83.9% to 90.0% of students reported favorable opinions of vaccination
McMurty et al. (2015)[a]	11 focus groups held chiropractic, naturopathy, and medical students regarding vaccination attitude evolution	Themes were revealed regarding the development of vaccination attitudes, including the roles of prior views, the influence of formal and informal information sources, and others.

Note. CAM = complementary and alternative medicine; CMCC = Canadian Memorial Chiropractic College.
[a]These two articles do not appear in Table 1. They were discovered through a different mechanism than the search outlined in Chapter 2. I located these articles while performing a search for digital object identifiers (DOIs) for the References section. These articles were produced when searching for DOIs for some of the other articles in this list. They were added to this table for completeness.

Appendix C: MRSA Nasal Carriage Rates Among College Students, Including Athletes and Students of the Heath Professions

Population	Source	Sample	Female (%)	Mean age (years)	Rate of MRSA nasal carriage (%)
College students	Bearman et al. (2010)	890 college students and 110 other volunteers in a university ambulatory care setting in Canada	64	23.48	1.6[a]
	Morita et al. (2007)	95 college students, 5 faculty	71	19-67 range	3
	Rim & Bacon III (2007)	221 college students, and 74 community members	66.4	189 participants were 18-32; 18-78 range	1
	Rohde et al. (2009)	203 college students	60	22	7.4
College athletes	Begier et al. (2003)	97 college football players and 29 trainers and staff; carriage was assessed in response to team infections	0 (players); unclear (trainers and staff)	10 cases aged 17-22–other age data not provided	0 (among players, trainers, and staff)
	Creech et al. (2009)	126 college student athletes; assessed across the on- and off-season (100 male football players, 26 female lacrosse players)	0 (football); 100 (lacrosse); 21 (overall)	Age not provided–69 football players were freshman and sophomores, no data for lacrosse players	16.5 during football season, 7.7 during postseason, 4.4 during the off-season, 8.4 during spring training, (statistically significant differences); for lacrosse, 23.1 during fall season, 16.3 in postseason, 11.5 in preseason, 15.4 in spring season (non-significant differences)
	Nguyen, et al. (2005)	11 college football players; only infected players were assessed, and only after initiating antibiotic therapy	0	19.5	9 (infected players concurrently colonized nasally)
	Oller et al. (2010)	145 college football players and wrestlers (95 athletes, 50 non-athlete controls)	0 (athletes); 54 (controls)	Data not provided	3 (among athletes); 0 (among non-athlete on-campus controls)
	Rackham et al. (2010)	277 college student athletes	35.4	All participants >18; mean not provided	1.8 - assessed at 2 institutions (3.2 at one institution, 0.65 at the other)
	Romano, et al. (2006)	107 college football players at the first 2 time points (2003) and 104 players at the last time point (2004)–significant prevention intervention in 2003	0	Data not provided	6.6 and 3.7 (2003), and 2.9 (2004)–complicated MRSA SSTI in 1.8 (2002), 15.8 (2003), and 0.96 (2004)

(table continues)

Population	Source	Sample	Female (%)	Mean age (years)	Rate of MRSA nasal carriage (%)
Students of the health professions	Bischoff, Wallis, Tucker, Reboussin, & Sheretz (2004)	127 medical students and 323 undergraduate students	50	23.15 (*S. aureus* carriers); 21.63 (non-carriers)	0.7 (methicillin resistance only - other resistance not included here); carriers were both medical and undergraduate students
	Chamberlain & Singh (2011)	132 second year medical students (82% of a class of 162 students–sex and age data refers to class population, not sample)	38	25.2	1.5
	Lum et al. (2014)	71 first year pharmacy students	56.3	75% were 18-24; 23.8% were 25-34; 1.3% were 35-44	4.2
	Miramonti et al. (2013)	152 emergency medical technician students	Data not provided	Data not provided	5.3
	Rohde et al. (2014)	Up to 87 nursing students assessed at up to 6 time points (62 at point 6)	87.4 at first time point	Data not provided	1.2 at first time point, 0 at the remaining 5 points
	Schwartz (2011)	34 physician assistant students preclinical rotation and postclinical rotation	70.6	Data not provided	0
	Slifka et al. (2009)	95 preclinical second-year and 87 clinical third-year medical students[b]	Data not provided	Data not provided	2 (second year); 3 (third year)

Note. All data are from the US. No articles regarding MRSA carriage in physical therapy or massage therapy students (who also frequently perform therapy with manual contact) were located–the same literature deficit as detected among chiropractic students. MRSA = methicillin resistant *Staphylococcus aureus;* SSTI = skin and soft tissue infection.
[a]An additional 1.4% were inducible dormant MRSA colonized. [b]The first published MRSA carriage data assessing only medical students in the United States–a letter to the editor in *Clinical Infectious Diseases.*

Appendix D: Significant MRSA Nasal Carriage Risk Factors and Effect Sizes in MRSA Carriage Studies Among U.S. College Students

Population	Source	Sample	Risk factor	Effect size	Comments
College students	Bearman et al. (2010)	890 college students and 110 other volunteers in a university ambulatory care setting in Canada	Dog ownership	*OR* 1.450 (*p* = 0.019)	Non-outbreak setting; confidence intervals not reported; risk factors were significant in multivariate analysis; factor significant in univariate but not multivariate analysis was total family household income ($60,000 - $75,000); other factors not found to be significant included gender; race; nation of origin (United States vs. other); sharing household items; sexual behavior; piercings, tattoos, or body shaving in the last year)
			Housing type (house is protective)	*OR* 0.040 (*p* = 0.007)	
			Older age	*OR* 1.046 (*p* = 0.040)	
	Morita et al. (2007)	95 college students, 5 faculty	NA	NA	Non-outbreak setting; no factors significant (gender, ethnicity, seawater exposure, prior staphylococcal infection, recent or current antibiotic use, and pets at home)
	Rim & Bacon III, (2007)	221 college students, and 74 community members	NA	NA	Non-outbreak setting; no factors were significant (various forms of healthcare visits in the last year, hospital employment [self or household member], household member hospitalized in prior 12 months, antibiotic use in the prior 6 months, and chronic illness)
	Rohde et al. (2009)	203 college students	Hospitalization in the past 12 months	*OR* 4.2, 95% *CI* [1.29, 13.36]	Non-outbreak setting; risk factors significant in univariate analysis; other risk factors were not significant (age; gender; ethnicity; skin infection, surgery, working in healthcare, incarceration, prior MRSA infection, use of intravenous drugs, or participation in athletics in the last 12 months; living in a dorm now or in the prior 3 months; or using antibiotics in the past 6 months)
			Skin infection in the past 12 months	*OR* 4.4, 95% *CI* [1.07, 18.24]	
College athletes	Begier et al. (2003)	97 college football players and 29 trainers and staff; carriage was assessed in response to team infections	Player position–wide receiver	*RR* 11.7, 95% *CI* [2.4, 56.8], *p* = 0.004	Outbreak investigation; factors were significant by Fisher's exact test for all except the frequency data, which used Cuzick's nonparametric test for trend
			Player position–cornerback	*RR* 17.5, 95% *CI* [3.8, 81.0], *p* = 0.001	
			Turf burns vs. no turf burns	*RR* 7.2, 95% *CI* [1.0, 54.5], *p* = 0.038	
			Any body shaving vs. none	*RR* 6.1, 95% *CI* [1.7, 22], *p* = 0.004	
			Body shaving at least twice vs. none	*RR* 6.7, 95% *CI* [1.7, 26.3], *p* = 0.004	
			Shaving groin or genitals vs. none	*RR* 9.3, 95% *CI* [2.3, 37.6], *p* = 0.010	

(table continues)

Population	Source	Sample	Risk factor	Effect size	Comments
College athletes (continued)	Creech et al. (2009)	126 college student athletes; assessed across the on- and off-season (100 male football players, 26 female lacrosse players)	Regular football season vs. spring training	16.5% vs. 8.4 %, *p* = 0.003	Non-outbreak setting; no person factors were significant for either sport (race, college year, football position, lacrosse position, recent antibiotic use, hospitalization in the past year, or - for lacrosse players only - season)
			Regular football season vs. off season	16.5% vs. 4.4%, *p* = 0.004	
			Regular football season vs. postseason	16.5% vs. 7.7%, *p* = 0.04	
	Nguyen et al. (2005)	11 college football players; only infected players were assessed, and only after initiating antibiotic therapy	Locker adjacent to or across from a teammate with a MRSA infection	*OR* 60.0, 95% *CI* [3.05, 3042], *p* = 0.001	Outbreak investigation; factors were significant by Fisher's exact test; other risk factors were not significant (sharing soap with teammates, having recent insect bites, sleeping in the locker or training room, and sharing whirlpool with teammates)
			Shared towels with teammates	*OR* 46.5, 95% *CI* [2.02, 2511], *p* = 0.005	
			Lived in a dormitory, fraternity, or on-campus housing	*OR* undefined, 95% *CI* [2.12, undefined], *p* = 0.003	
	Oller et al. (2010)	145 college football players and wrestlers (95 athletes, 50 non-athlete controls)	NA	NA	Non-outbreak setting; the study was not arranged to report risk factors for nasal carriage; in this study, fingertip MRSA carriage greatly exceeded nasal carriage in football players, but not wrestlers or controls ($p < 0.05$)
	Rackham et al. (2010)	277 college student athletes	NA	NA	Non-outbreak setting; no factors were significant (age; race; gender; living on campus; sport; number of roommates; whirlpool use; nose picking; sharing towels, soap, or razors; skin infection, rash, surgery, antibiotic treatment, or hospitalization in the last year; past MRSA diagnosis; and recent healthcare.
	Romano et al. (2006)	107 college football players at the first 2 time points (2003) and 104 players at the last time point (2004)–significant prevention intervention in 2003	NA	NA	Outbreak investigation and intervention; the study was not designed to assess or report risk factors for nasal carriage

(table continues)

Population	Source	Sample	Risk factor	Effect size	Comments
Students of the health professions	Bischoff et al. (2004)	127 medical students and 323 undergrad students	NA	NA	Non-outbreak investigation; study was largely of *S. aureus* nasal carriage; risk factors for nasal carriage of MRSA cannot be determined from this study
	Chamberlain & Singh (2011)	132 second year medical students (82% of a class of 162 students–sex and age data refers to class population, not sample)	NA	NA	Non-outbreak investigation; the study did not include risk factors for MRSA nasal carriage
	Lum et al. (2014)	71 first year pharmacy students	NA	NA	Non-outbreak investigation; the study did not include risk factors for MRSA nasal carriage
	Miramonti et al. (2013)	152 emergency medical technician students	NA	NA	Non-outbreak investigation; the study did not include risk factors for MRSA nasal carriage
	Rohde et al. (2014)	Up to 87 nursing students assessed at up to 6 time points (62 at point 6)	NA	NA	Non-outbreak investigation; a variety of risk factors were explored, but they were not definitively associated with MRSA, but with *S. aureus* and other species (these others were associated with volunteering in health settings and participation in gyms – but again not linked to MRSA)
	Schwartz (2011)	34 physician assistant students preclinical rotation and postclinical rotation	NA	NA	Non-outbreak investigation; no factors were significant for MRSA carriage (geography, marriage, team sports, employment, use of gym facilities); sharing glassware was associated with MSSA carriage ($p \leq 0.001$)
	Slifka et al. (2009)	95 preclinical second-year and 87 clinical third-year medical students	NA	NA	Non-outbreak investigation; the only risk factor reported (year of study) was not significantly associated with nasal carriage

Note. All data are from the US. *CI* = confidence interval; *OR* = odds ratio; *RR* = relative risk; MRSA = methicillin resistant *Staphylococcus aureus*; MSSA = methicillin sensitive *Staphylococcus aureus*; NA = not applicable/not provided.

Appendix E: MRSA Nasal Carriage Rates Among Students of Health Professions Outside the United States

Source	Sample	Female (%)	Mean age (years)	Rate of MRSA nasal carriage (%)
Adesida et al. (2007)	182 third year (clinical) medical students in Nigeria	50	23.9	0
Bettin, Causil, & Reyes (2012)	372 medical students, comprising essentially the entire student population of a medical school in Columbia, assessed at 5 time points	Data not provided	19 ± 2.1	1.61 positive during at least one time point; no association with year of study
De Giusti et al. (2013)	106 medical and undergraduate/postgraduate prevention technician students in Rome, Italy	35.8	47% under 26, 53% 26 and older	0
Du et al. (2011)	935 medical students in China	Data not provided	Data not provided	3
Güçlü et al. (2007)	31 first year, 47 second year, 41 third year, 18 fourth year, 28 fifth year, and 14 intern medical students (179 students) in Turkey	48 (first); 47 (second); 46 (third); 44 (fourth); 39 (fifth); 50 (interns)	Data not provided	0 (first year); 0 (second year); 2.4 (third year); 0 (fourth year); 7 (fifth year); 14 (interns); higher carriage in clinical years not statistically significant
Higuchi et al. (2007)	98 preclinical medical students in Japan	Data not provided	Data not provided	0
Ishihara et al. (2010)	51 students, 21 staff, and 20 veterinarians at a university in Japan in 2007; and 74 students, 19 staff, and 24 veterinarians at the same location in 2008; in 2007, 36 of the students and staff were nonclinical	Data not provided	Data not provided	0 (nonclinical students and staff); 5.9 (all students), 14.3 (staff), and 25 (veterinarians) in 2007; 2.7 (all students), 0 (staff), 23.5 (veterinarians) in 2008[a]
Kim et al. (2015)	215 second- and third-year nursing students in Korea	93	21.92 ± 3.52	1.4 overall; no change by year of study or period of clinical practice
Kingdom et al. (1983)	75 preclinical first year, 75 early clinical third year, and 69 late clinical fifth year medical students in Ireland	Data not provided	Data not provided	0
Ma et al. (2011)	2103 preclinical medical students in China	48.5	20.5	2.17
Piechowicz et al. (2011)	156 preclinical and 165 clinical medical students in Poland	Data not provided	Data not provided	0.9 overall, all strains in clinical students (1.8 among clinical students)
Prates et al. (2010)	250 undergraduate students in multiple health fields in Brazil	62.8	18 to 27 range	5.8
Renushri et al. (2011)	119 clinical nursing and 100 nonclinical pharmacy students in India	Data not provided	18 to 23 range (nursing)–data not provided for pharmacy	8.4 (nursing); 1 (pharmacy)

(table continues)

Source	Sample	Female (%)	Mean age (years)	Rate of MRSA nasal carriage (%)
Stubbs, Pegler, Vickery, & Harbour, (1994)	193 preclinical first year, 195 early clinical third year, and 375 fourth year medical students; and 45 graduated hospital interns in Australia	34	Data not provided	0 (antibiotic resistant *S. aureus* more prevalent with increasing clinical exposure)
Treesirichod et al. (2013)	128 students tested at three points: prehospital rotation, after first rotation, and after last rotation in Thailand	58.6	20.9 ± 0.9	0 all stages
Trépanier et al. (2014)	247 students in preclinical medical undergraduate education and 250 medical students in residency in Quebec, Canada	72.5 (undergrad); 65.2 (residents)	21 (undergrad); 26 (residents)	0 overall, 0 (undergrad); 0.4 (residents)
Zakai (2015)	150 clinical students and interns and 32 controls (third year preclinical students)	48.7 (clinical) 43.8 (controls)	Data not provided	6.7 (clinical), 0 (preclinical), significant difference, $p < 0.05$

Note. MRSA = methicillin resistant *Staphylococcus aureus*
[a]Ishihara et al. (2011) were the only authors to provide 95% confidence intervals. Rates (%) and 95% confidence intervals were 0 [0, 8.0] for nonclinical students and staff, 5.9 [1.2, 16.2] for all students, 14.3 [3.0, 36.3] for staff, and 25 [8.7, 49.1] for veterinarians in 2007 and 2 [0.3, 9.4] for students, 0 [0, 14.6] for staff, and 23.5 [10.7, 41.2] for veterinarians in 2008. The difference between veterinarians and students was not significant in 2007 ($p = 0.08$) but was in 2008 ($p < 0.01$). The difference between veterinarians and staff was significant in 2008 ($p < 0.01$).

Appendix F: VCU Health System MCV Hospitals and Physicians CA-MRSA Questionnaires

This survey instrument was used by Bearman et al. (2010) to assess CA-MRSA risk factors in a large pool of (mostly) undergraduate students. Dr. Gonzalo M. Bearman provided permission to use the survey by email on May 29, 2014 (personal communication): “Dear Jonathan [*sic*], You may use our questionnaire. In any related publications/abtracts [*sic*], please reference our survey tool. Thanks- Gonzalo Bearman MD, MPH, FACP.” The questionnaire was not published in the article referenced above and did not fall under the publication’s copyright. For my study, the questions I used directly from this survey in their exact wording in my questionnaire (Appendix A) regarded age, race, gender, and nation of origin. The modifications to the questionnaire (aside from not using the entire questionnaire) in my study are mild changes related to the question regarding shared items and the questions on incarceration and intravenous drug use. The modifications were: the removal of the clause “in your household,” the replacement of prior item names with the shared items in my study (lotion and patient practice gowns), elimination of the follow up question regarding whom the items were shared with, and removal of the phrase “in the last year” from the question on incarceration and intravenous drug use.

Appendix G: Invasive Methicillin-Resistant Staphylococcus Aureus Active Bacterial Core Surveillance (ABCs) Case Report--2013

This instrument is the report form used by the CDC to collect information on cases of invasive MRSA as part of active surveillance (2013b). Item 17 from that questionnaire is the source of the healthcare exposure wording in my study. In that section of the surveillance form, the epidemiologic classification is used to categorize MRSA as HA-MRSA or CA-MRSA (CDC, 2013b). The form is available for non-commercial use from this government agency; no permission is required for use.

The questions about healthcare exposures in the present study were modified in the slightest regard from their presentation in this questionnaire. Where the original questionnaire phrased questions such as “surgery within year before initial culture date” (CDC, 2013b, p2), the present study truncated and asked “surgery within 12 months.” Any question that asked “before initial culture date” or “prior to the initial culture” had those and like phrases truncated and removed in the questionnaire (as this CDC report was designed for reporting by healthcare providers). The other mild modification was to include a direction in question form such as “Which of the following apply to *this* MRSA infection (check all that apply):” because the original case report (CDC, 2013b) was never completed in first person. One HRF asked specifically about “the last 2 days” (CDC, 2013b, p.2)–in the questionnaire for the present study it was changed to “one year” (Appendix A) to be consistent with all the other healthcare exposures. The question about prior infection was asked about prior to chiropractic college or since chiropractic college matriculation.

Appendix H: A Questionnaire About Chiropractic Hand and Table Sanitation as Used in Evans and Breshears (2007)

Evans and Breshears (2007) used a survey questionnaire to assess chiropractic student attitudes and behaviors regarding hygiene practices. A similar survey was later used in Evans, Ramcharan, Ndetan et al. (2009). I used two questions in my questionnaire that were directly from the Evans & Breshears (2007) survey: question 2 regarding frequency of hand sanitation and question 6 regarding frequency of table sanitation. Question 2 was modified in the slightest regard to state “sanitize” instead of “wash” for clarification; hand sanitization is a more appropriate term in this context. Question 6 was modified to include the word “technique” in “palpation/technique lab.” The publisher (ACA) provided permission to reproduce and use the questionnaire. In response to my email request “... I simply need a letter ... **granting permission for me to reuse/reprint/and adapt the questionnaire in this figure for use in my questionnaire and dissertation...**” Lori Burkhart, Director of Publications for the ACA, responded on August 18, 2014 (personal communication) “... yes of course go ahead and use the JACA article with attribution. Lori.” Aside from the minimal modification noted, the named questions were used in their exact wording in the study questionnaire. The questionnaire is reprinted with permission. The questionnaire is from “Attitudes and behaviors of chiropractic college students on hand sanitizing and treatment table disinfection: Results of initial survey and focus group,” by Evans and Breshears (2007), originally published in *Journal of the American Chiropractic Association, 44*(4), p.21-22. The copyright was secured in 2007 by the American Chiropractic Association.

Fig. 1. Student survey

INFECTION CONTROL SURVEY

Please select a single answer that best describes your attitude or beliefs regarding infection control in chiropractic.

1. Regarding the importance of routine hand washing before and after each contact with other students or patients, what best describes your current attitude?

☐ It is **very unimportant**
☐ It is **unimportant**
☐ It is **neither** unimportant or important
☐ It is **important**
☐ It is **very important**

2. Regarding your treatment or examination of fellow students or patients, which most appropriately describes your hand washing practices?

☐ After contact with students/patients, I **never** wash my hands
☐ After contact with students/patients, I **rarely** wash my hands
☐ After contact with students/patients, I **occasionally** wash my hands
☐ After contact with students/patients, I **frequently** wash my hands
☐ After contact with students/patients, I **always** wash my hands

3. Do you carry a personal hand sanitizer with you?

☐ Yes ☐ No

4. If hand sanitizer dispensers were placed in convenient locations in palpation labs or clinics, which statement best describes how likely you would be to use them after contact?

☐ I **wouldn't** use them at all
☐ I would **rarely** use them before and after student/patient contact
☐ I would **occasionally** use them before and after student/patient contact
☐ I would **frequently** use them before and after student/patient contact
☐ I would **always** use them before and after student/patients contact

5. When using treatment tables in palpation labs or clinics, which best describes your current efforts regarding changing face-paper?

☐ I **never** change the face-paper
☐ I **rarely** change the face-paper
☐ I **occasionally** change the face-paper
☐ I **frequently** change the face-paper
☐ I **always** change the face-paper

6. When using treatment tables in palpation labs or clinics which best describes your current efforts to sanitize the table surface in addition to changing the face-paper?

☐ I **never** wipe the table with a sanitizing agent
☐ I **rarely** wipe the table with something to sanitize its surface
☐ I **occasionally** wipe the table with something to sanitize its surface
☐ I **frequently** wipe the table with something to sanitize its surface
☐ I **always** wipe the table with something to sanitize its surface

7. If you currently sanitize the table surface with something, what do you use? (If you do not currently wipe the table's surface, skip to the next question.)

☐ Tissue or paper towel
☐ Tissue or paper towel with soap and water
☐ Tissue or paper towel and hand sanitizing gel
☐ Other substance (Please list) ____

8. Regarding your fellow students, instructors, or clinic doctors, what best describes what you have noticed in palpation labs or clinics at Parker College of Chiropractic?

☐ After contact with students/patients hand washing is **never** practiced
☐ After contact with students/patients hand washing is **rarely** practiced
☐ After contact with students/patients hand washing is **occasionally** practiced
☐ After contact with students/patients hand washing is **frequently** practiced
☐ After contact with students/patients hand washing is **always** practiced

9. What trimester are you currently in? _________________

10. Are you: ☐ Male ☐ Female

THANK YOU FOR YOUR PARTICIPATION

Appendix I: IRB Notes Regarding Participating Campuses

Walden provided IRB approval on 7/21/2015. A minor change was approved on 8/26/15. The other campuses provided IRB approval and/or administrative approval to participate in the study, based on Walden's approval. The first provided approval on 7/24/15. The last provided approval on 9/8/15. I have records of when approvals were received, but I am not disclosing dates to mask participating and non-participating colleges, as some colleges have multiple campuses, and the number of campuses or colleges providing approval on given dates could be used to attempt to determine participants and non-participants.

Colleges that did not provide IRB and/or administrative approval had varying reasons or no provided reason. The following were the categories of reasons that institutions were not participants in the study: concern for survey fatigue in students, approval required a process Walden did not support for dissertation research or the researcher could not complete in timely fashion, concern for the sensitivity of the data collected, being my employer, and no provided reason.

One participating chiropractic college required it's own streamlined IRB application for it's own participation approval, based on the approval granted by Walden. That IRB application is not reprinted here to mask the identity of the college, but is retained by the researcher. That application simply reformatted the Walden application material for this college; there were no study changes made to accommodate that college's IRB. That college provided approval with Walden's IRB remaining the IRB of record.

Appendix J: MRSA SSTI After Chiropractic Matriculation: Stratum Specific Analysis

Variable	Covariable	Stratum	OR	95% *CI*	Applicable value
Hand hygiene			Crude: 2.069	[0.026, 163.190]	Fisher's p = 0.548
	Campus		**M-H combined: 0.875[a]**	[0.050, 15.326]	$\chi^2(1) = 0.01$; $p = 0.928$
		Campus 6	**Stratum specific: 0.875[a]**	[0.010, 73.532]	M-H weight: 0.500
		Others[b]	Stratum specific: *	*	M-H weight: 0.000
	Jail		M-H combined: 2.053	[0.127, 33.174]	$\chi^2(1) = 0.27$; $p = 0.606$
		No	Stratum specific: 2.053	[0.026, 161.929]	M-H weight: 0.325
		Yes	Stratum specific: *	*	M-H weight: 0.000
	IV drugs		M-H combined: 2.081	[0.129, 33.63]	$\chi^2(1) = 0.28$; $p = 0.598$
		No	Stratum specific: 2.082	[0.026, 164.181]	M-H weight: 0.322
		Yes	Stratum specific: *	*	M-H weight: 0.000
	Military		M-H combined: 2.041	[0.126, 32.972]	$\chi^2(1) = 0.26$; $p = 0.601$
		No	Stratum specific: 2.041	[0.026, 160.977]	M-H weight: 0.327
		Yes	Stratum specific: *	*	M-H weight: 0.000
	Age >28		M-H combined: 1.961	[0.128, 29.868]	$\chi^2(1) = 0.25$; $p = 0.614$
		No	Stratum specific: *	[0.000, *]	M-H weight: 0.000
		Yes	**Stratum specific: 0.000[a]**	[0.000, *]	M-H weight: 0.349
	Gender (male)		**M-H combined: 1.780[a]**	[0.109, 28.977]	$\chi^2(1) = 0.17$; $p = 0.683$
		No	**Stratum specific: 1.780[a]**	[0.022, 141.000]	M-H weight: 0.355
		Yes	Stratum specific: *	*	M-H weight: 0.000
	Race (nonwhite)		M-H combined: 1.928	[0.119, 163.190]	$\chi^2(1) = 0.22$; $p = 0.639$
		No	Stratum specific: 1.928	[0.024, 152.242]	M-H weight: 0.339
		Yes	Stratum specific: *	*	M-H weight: 0.000
	Healthcare exposures		M-H combined: 1.959	[0.121, 31.658]	$\chi^2(1) = 0.23$; $p = 0.630$
		No	Stratum specific: 1.959	[0.025, 154. 570]	M-H weight: 0.336
		Yes	Stratum specific: *	*	M-H weight: 0.000
	Prior MRSA SSTI		M-H combined: *	*	$\chi^2(1) = 1.96$; $p = 0.161$
		No	Stratum specific: *	[0.000, *]	M-H weight: 0.000
		Yes	Stratum specific: *	*	M-H weight: 0.000

(table continues)

Variable	Covariable	Stratum	OR	95% *CI*	Applicable value
Hand hygiene (cont.)	Non-U.S. origin		M-H combined: 2.235	[0.138. 36.160]	$\chi^2(1) = 0.34$; $p = 0.562$
		No	Stratum specific: 2.235	[0.028, 176.361]	M-H weight: 0.306
		Yes	Stratum specific: *	*	M-H weight: 0.000
Table hygiene			Crude: 2.069	[0.026, 163.190]	Fisher's $p = 0.548$
	Campus		**M-H combined: 0.429**[a]	[0.024, 7.632]	$\chi^2(1) = 0.34$; $p = 0.561$
		Campus 6	**Stratum specific: 0.429**[a]	[0.005, 37.345]	M-H weight: 0.656
		Others[b]	Stratum specific: *	*	M-H weight: 0.000
	Jail		M-H combined: 0.487	[0.030, 7.87]	$\chi^2(1) = 0.27$; $p = 0.606$
		No	Stratum specific: 0.487	[0.006, 38.639]	M-H weight: 0.668
		Yes	Stratum specific: *	*	M-H weight: 0.000
	IV drugs		M-H combined: 0.495	[0.031, 7.997]	$\chi^2(1) = 0.25$; $p = 0.614$
		No	Stratum specific: 0.495	[0.006, 39.243]	M-H weight: 0.664
		Yes	Stratum specific: *	*	M-H weight: 0.000
	Military		M-H combined: 0.483	[0.030, 7.797]	$\chi^2(1) = 0.27$; $p = 0.601$
		No	Stratum specific: 0.483	[0.006, 38.267]	M-H weight: 0.670
		Yes	Stratum specific: *	*	M-H weight: 0.000
	Age >28		M-H combined: 0.491	[0.027, 8.817]	$\chi^2(1) = 0.22$; $p = 0.636$
		No	Stratum specific: *	[0.000, *]	M-H weight: 0.000
		Yes	**Stratum specific: 0.000**[a]	[0.000, *]	M-H weight: 0.622
	Gender (male)		**M-H combined: 0.562**[a]	[0.035, 9.149]	$\chi^2(1) = 0.17$; $p = 0.683$
		No	**Stratum specific: 0.562**[a]	[0.007, 44.846]	M-H weight: 0.633
		Yes	Stratum specific: *	*	M-H weight: 0.000
	Race (nonwhite)		M-H combined: 0.464	[0.029, 7.514]	$\chi^2(1) = 0.31$; $p = 0.581$
		No	Stratum specific: 0.464	[0.006, 36.878]	M-H weight: 0.678
		Yes	Stratum specific: *	*	M-H weight: 0.000
	Healthcare exposures		M-H combined: 0.472	[0.029, 7.630]	$\chi^2(1) = 0.29$; $p = 0.589$
		No	Stratum specific: 0.472	[0.006, 37.450]	M-H weight: 0.675
		Yes	Stratum specific: *	*	M-H weight: 0.000
	Prior MRSA SSTI		**M-H combined: 0.803**[a]	[0.031, 20.749]	$\chi^2(1) = 0.01$; $p = 0.907$
		No	Stratum specific: *	[0.000, *]	M-H weight: 0.000
		Yes	**Stratum specific: 0.000**[a]	[0,000, *]	M-H weight: 0.400

(table continues)

Variable	Covariable	Stratum	OR	95% *CI*	Applicable value
Table hygiene (cont.)	Non-U.S. origin		M-H combined: 0.495	[0.031, 7.997]	$\chi^2(1) = 0.26$; $p = 0.614$
		No	Stratum specific: 0.495	[0.006, 39.243]	M-H weight: 0.664
		Yes	Stratum specific: *	*	M-H weight: 0.000
Share lotion			Crude: 4.636	[0.058, 365.303]	Fisher's $p = 0.327$
	Campus		**M-H combined: 29.000[a]**	[0.954, 881.396]	$\boldsymbol{\chi^2(1) = 6.75; p = 0.009}$[c]
		Campus 6	**Stratum specific: 29.000[a]**	[0.185, 2347.222]	M-H weight: 0.031
		Others[b]	Stratum specific: *	*	M-H weight: 0.000
	Jail		M-H combined: 4.577	[0.282, 74.368]	$\chi^2(1) = 1.37$; $p = 0.242$
		No	Stratum specific: 4.577	[0.057, 360.718]	M-H weight: 0.178
		Yes	Stratum specific: *	*	M-H weight: 0.000
	IV drugs		M-H combined: 4.808	[0.296, 78.107]	$\chi^2(1) = 1.48$; $p = 0.224$
		No	Stratum specific: 4.808	[0.060, 378.830]	M-H weight: 0.171
		Yes	Stratum specific: *	*	M-H weight: 0.000
	Military		M-H combined: 4.516	[0.278, 73.378]	$\chi^2(1) = 1.34$; $p = 0.246$
		No	Stratum specific: 4.519	[0.057, 356.080]	M-H weight: 0.180
		Yes	Stratum specific: *	*	M-H weight: 0.000
	Age >28		M-H combined: 4.801	[0.272, 84.702]	$\chi^2(1) = 1.30$; $p = 0.254$
		No	Stratum specific: 0.000	[0.000, *]	M-H weight: 0.165
		Yes	Stratum specific: *	[0.000, *]	M-H weight: 0.000
	Gender (male)		M-H combined: 5.074	[0.308, 83.639]	$\chi^2(1) = 1.58$; $p = 0.209$
		No	Stratum specific: 5.074	[0.062, 401.085]	M-H weight: 0.163
		Yes	Stratum specific: *	*	M-H weight: 0.000
	Race (nonwhite)		M-H combined: 4.283	[0.263, 69.748]	$\chi^2(1) = 1.23$; $p = 0.267$
		No	Stratum specific: 4.283	[0.053, 337.810]	M-H weight: 0.188
		Yes	Stratum specific: *	*	M-H weight: 0.000
	Healthcare exposures		M-H combined: 4.577	[0.282, 74.368]	$\chi^2(1) = 1.37$; $p = 0.242$
		No	Stratum specific: 4.577	[0.572, 360.718]	M-H weight: 0.178
		Yes	Stratum specific: *	*	M-H weight: 0.000
	Prior MRSA SSTI		**M-H combined: 3.989[a]**	[0.213, 74.818]	$\chi^2(1) = 0.78$; $p = 0.379$
		No	**Stratum specific: 0.000[a]**	[0.000, *]	M-H weight: 0.175
		Yes	Stratum specific: *	[0.000, *]	M-H weight: 0.000

(table continues)

Variable	Covariable	Stratum	OR	95% *CI*	Applicable value
Share lotion (cont.)	Non-U.S. origin		M-H combined: 4.500	[0.277, 73.169]	$\chi^2(1) = 1.33$; $p = 0.248$
		No	Stratum specific: 4.500	[0.056, 354.739]	M-H weight: 0.181
		Yes	Stratum specific: *	*	M-H weight: 0.000
Share gowns			Crude: 0.000	[0.000, 15.015][d]	Fisher's $p = 1.000$
	Campus		M-H combined: 0.000	*	χ^2**(1) =** 0.14; $p = 0.711$
		Campus 6	Stratum specific: 0.000	[0.000, 39.693]	M-H weight: 0.125
		Others[b]	Stratum specific: *	*	M-H weight: 0.000
	Jail		M-H combined: 0.000	*	$\chi^2(1) = 0.28$; $p = 0.595$
		No	Stratum specific: 0.000	[0.000, 13.922]	M-H weight: 0. 247
		Yes	Stratum specific: *	*	M-H weight: 0.000
	IV drugs		M-H combined: 0.000	*	$\chi^2(1) = 0.26$; $p = 0.609$
		No	Stratum specific: 0.000	[0.000, 15.061]	M-H weight: 0.230
		Yes	Stratum specific: *	*	M-H weight: 0.000
	Military		M-H combined: 0.000	*	$\chi^2(1) = 0.27$; $p = 0.607$
		No	Stratum specific: 0.000	[0.000, 14.836]	M-H weight: 0.233
		Yes	Stratum specific: *	*	M-H weight: 0.000
	Age >28		M-H combined: 0.000	*	$\chi^2(1) = 0.25$; $p = 0.618$
		No	Stratum specific: 0.000	[0.000, *]	M-H weight: 0.126
		Yes	Stratum specific: 0.000	[0.000, *]	M-H weight: 0.094
	Gender (male)		M-H combined: 0.000	*	$\chi^2(1) = 0.28$; $p = 0.600$
		No	Stratum specific: 0.000	[0.000, 14.523]	M-H weight: 0.241
		Yes	Stratum specific: *	*	M-H weight: 0.000
	Race (nonwhite)		M-H combined: 0.000	*	$\chi^2(1) = 0.26$; $p = 0.611$
		No	Stratum specific: 0.000	[0.000, 15.266]	M-H weight: 0.229
		Yes	Stratum specific: *	*	M-H weight: 0.000
	Healthcare exposures		M-H combined: 0.000	*	$\chi^2(1) = 0.26$; $p = 0.613$
		No	Stratum specific: 0.000	[0.000, 15.400]	M-H weight: 0.226
		Yes	Stratum specific: *	*	M-H weight: 0.000
	Prior MRSA SSTI		M-H combined: 0.000	*	$\chi^2(1) = 0.38$; $p = 0.540$
		No	Stratum specific: 0.000	[0.000, *]	M-H weight: 0.113
		Yes	Stratum specific: 0.000	[0.000, *]	M-H weight: 0.200

(table continues)

Variable	Covariable	Stratum	OR	95% *CI*	Applicable value
Share gowns (cont.)	Non-U.S. origin		M-H combined: 0.000	*	$\chi^2(1) = 0.30$; $p = 0.584$
		No	Stratum specific: 0.000	[0.000, 13.103]	M-H weight: 0.260
		Yes	Stratum specific: *	*	M-H weight: 0.000
Stage (patient care)			Crude: 2.523	[0.032, 198.891]	Fisher's $p = 0.490$
	Campus		**M-H combined: 1.500**[a]	[0.085, 26.361]	χ^2 $(1) = 0.08$; $p = 0.783$
		Campus 6	**Stratum specific: 1.500**[a]	[0.018, 124.185]	M-H weight: 0.375
		Others[b]	Stratum specific: *	*	M-H weight: 0.00
	Jail		M-H combined: 2.453	[0.152, 39.664]	$\chi^2(1) = 0.42$; $p = 0.515$
		No	Stratum specific: 2.452	[0.031, 193.411]	M-H weight: 0.288
		Yes	Stratum specific: *	*	M-H weight: 0.000
	IV drugs		M-H combined: 2.512	[0.155, 40.609]	$\chi^2(1) = 0.45$; $p = 0.503$
		No	Stratum specific: 2.512	[0.032, 198.040]	M-H weight: 0.283
		Yes	Stratum specific: *	*	M-H weight: 0.000
	Military		M-H combined: 2.425	[0.150, 39.212]	$\chi^2(1) = 0.41$; $p = 0.520$
		No	Stratum specific: 2.425	[0.031, 191.253]	M-H weight: 0.290
		Yes	Stratum specific: *	*	M-H weight: 0.000
	Age >28		M-H combined: 2.694	[0.110, 66.282]	$\chi^2(1) = 0.32$; $p = 0.573$
		No	**Stratum specific: 0.000**[a]	[0.000, *]	M-H weight: 0.214
		Yes	Stratum specific: *	[0.000, *]	M-H weight: 0.000
	Gender (male)		M-H combined: 2.644	[0.032, 198.891]	$\chi^2(1) = 0.50$; $p = 0.480$
		No	Stratum specific: 2.644	[0.033, 209.278]	M-H weight: 0.271
		Yes	Stratum specific: *	*	M-H weight: 0.000
	Race (nonwhite)		M-H combined: 2.375	[0.147, 38.491]	$\chi^2(1) = 0.39$ $p = 0.531$
		No	Stratum specific: 2.375	[0.030, 187.490]	M-H weight: 0.294
		Yes	Stratum specific: *	*	M-H weight: 0.000
	Healthcare exposures		M-H combined: 2.372	[0.147, 38.360]	$\chi^2(1) = 0.39$; $p = 0.531$
		No	Stratum specific: 2.372	[0.230, 187.088]	M-H weight: 0.295
		Yes	Stratum specific: *	*	M-H weight: 0.000
	Prior MRSA SSTI		M-H combined: 2.458	[0.161, 37. 606]	$\chi^2(1) = 0.42$; $p = 0.519$
		No	**Stratum specific: 0.000**[a]	[0.000, *]	M-H weight: 0.285
		Yes	Stratum specific: *	[0.000, *]	M-H weight: 0.200

(table continues)

Variable	Covariable	Stratum	OR	95% *CI*	Applicable value
Stage (patient care; cont.)	Non-U.S. origin		M-H combined: 2.438	[0.151, 39.447]	$\chi^2(1) = 0.42$; $p = 0.518$
		No	Stratum specific: 2.438	[0.031, 192. 289]	M-H weight: 0. 0.289
		Yes	Stratum specific: *	*	M-H weight: 0.000

Note. OR = odds ratio. *CI* = confidence interval. MRSA = methicillin-resistant *Staphylococcus aureus.* SSTI = skin and soft tissue infection. M-H = Mantel-Haenszel. Calculations performed using Stata (Small Stata version 14.1). Items in boldface have a pooled Mantel-Haenszel *OR* or stratum specific *OR* that varies more than 10% from the crude *OR* (indicating potential confounding), or a value with a significant χ^2 ($p < 0.05$) indicating potential effect modification. Items with a "*" indicate that Stata did not return a value due to the limited number of cases. Fisher's Exact *p* values are 2-sided, and calculated using SPSS (version 21.0.0.0).

[a]Potential confounding is present; a calculated stratum odds ratio varies by more than 10% from the crude odds ratio. Both strata odds ratios would need to be similar to each other - and both vary from the crude odds ratio by 10% - for true confounding. However, because of the small number of cases detected, one stratum did not return a stratum specific odds ratio. Therefore, this represents potential confounding, as at least one stratum odds ratio varied by more than 10% from the crude odds ratio. The pooled Mantel-Haenszel estimate should be used. [b]Others are campuses 1-5 and 7-9, which each had the same values individually. The value listed here is the individual value produced for each campus separately. [c]There was interaction between campus, sharing lotion, and postmatriculation MRSA SSTI, with the Mantel-Haenszel pooled estimate varying significantly from unity. The pooled M-H value should not be used where potential effect modification is present. [d]Per Small Stata (version 14.1), "Exact confidence intervals not possible with zero count cells." In these instances, Cornfield values are reported rather than exact values.