Prevalence of Methicillin-Resistant Staphylococcus aureus (MRSA) Colonization in Medical Students at the El Paso/Cd. Juarez Border Region

Samantha Michelle Meza

University of Texas at El Paso, samanthamichelle08@yahoo.com

Follow this and additional works at: https://digitalcommons.utep.edu/open_etd

Recommended Citation
https://digitalcommons.utep.edu/open_etd/1489
PREVALENCE OF METHICILLIN-RESISTANT STAPHYLOCOCCUS AUREUS (MRSA) COLONIZATION IN MEDICAL STUDENTS AT THE EL PASO/CD. JUAREZ BORDER REGION

SAMANTHA MICHELLE MEZA
Master’s Program in Public Health

APPROVED:

______________________________
Delfina C. Domínguez, Ph.D., Chair

______________________________
Gabriel Ibarra-Mejia, Ph.D.

______________________________
Debra Bramblett, Ph.D.

______________________________
Charles Ambler, Ph.D.
Dean of the Graduate School
Dedication

This thesis is dedicated to my family, especially my parents and my husband, for providing me with unconditional support as I completed my graduate education. My family encouraged me to pursue a higher education and helped me every step of the way. I am forever grateful to them for their love and their dedication in helping me achieve my academic goals.
PREVALENCE OF METHICILLIN-RESISTANT *STAPHYLOCOCCUS AUREUS* (MRSA) IN MEDICAL STUDENTS AT THE EL PASO/CD. JUAREZ BORDER REGION

by

SAMANTHA MICHELLE MEZA, B.S.

THESIS

Presented to the Faculty of the Graduate School of The University of Texas at El Paso in Partial Fulfillment of the Requirements for the Degree of

MASTER OF PUBLIC HEALTH

Department in Public Health Sciences

THE UNIVERSITY OF TEXAS AT EL PASO

May 2018
Acknowledgements

I would like to thank my mentor, Dr. Delfina Dominguez, for guiding me as an undergraduate student and continuing to guide me until the completion of my graduate education. I am grateful for your constant support in all my endeavors, both professional and academic. I would also like to thank Dr. Gabriel Ibarra-Mejia for helping me with the data analysis for this thesis project. In addition, I want to thank Dr. Bramblett and the rest of the research team from Burrell College of Osteopathic Medicine for this collaboration and for their support in the completion of this thesis project.
Abstract

Background: Due to the constant use, misuse, and over-prescription of antibiotics, antibiotic resistance has become a global public health threat. Methicillin-Resistant *Staphylococcus aureus* (MRSA) continues to prevail in healthcare settings and is the cause of many nosocomial infections worldwide. A risk factor for developing an active MRSA infection is the colonization of the pathogen in the anterior nares. Over the past two decades, MRSA infections have increased in both the hospital and the community setting, often infecting healthy individuals lacking common risk factors. Healthcare workers with constant exposure to MRSA are more likely to be colonized and can potentially serve as vectors in the transmission of MRSA to hospital patients. **Objective:** The objective of this project is to establish the carrier status of first-year osteopathic medical students by conducting nasal swabs on the participants and characterizing the bacteria through selective media and genetic characterization methods. **Methods:** Researchers from Burrell College of Osteopathic Medicine recruited first-year osteopathic medical students to serve as subject participants and graduate students from New Mexico State University to serve as control participants. BCOM researchers administered a participant survey and conducted nasal swabs on all participants. The samples were then transported to UTEP for laboratory analysis where they underwent identification for *Staphylococcus aureus* and MRSA. **Results:** 36 participants were recruited, 32 subjects and 4 controls. 33.3% resulted in being positive for *Staphylococcus aureus* colonization, 31.3% of subjects and 50% of controls. None of the samples resulted in being positive for MRSA. **Conclusions:** The results of this thesis study are similar to those of other studies who examined prevalence of colonization in pre-clinical medical students. In addition, the results are similar to the CDC’s estimate of 33% of individuals being *S. aureus* carriers and 2% being MRSA carriers. The findings of this study are relevant to U.S.-Mexico border region by examining the
colonization prevalence in future healthcare professionals and continuing the surveillance to assess the impact of healthcare exposure on nasal colonization.
# Table of Contents

Acknowledgements........................................................................................................................................... v

Abstract................................................................................................................................................................. vi

Table of Contents .................................................................................................................................................. viii

List of Tables ........................................................................................................................................................ x

List of Figures ....................................................................................................................................................... xi

Chapter 1: Introduction .......................................................................................................................................... 1

Chapter 2: Background and Significance ............................................................................................................. 4

2.1 Methicillin-Resistant *Staphylococcus aureus* Infections (MRSA) ................................................................. 4

2.2 U.S./Mexico Border Region ........................................................................................................................... 13

Chapter 3: Goal and Objective ........................................................................................................................... 22

3.1 Goal and Objective ......................................................................................................................................... 22

Chapter 4: Study Aims and Hypothesis .............................................................................................................. 23

4.1 Aims ................................................................................................................................................................. 23

4.2 Hypotheses .................................................................................................................................................... 23

Chapter 5: Methods and Materials .................................................................................................................... 24

5.1 Sample Collection & Recruitment ................................................................................................................ 24

5.2 Bacterial Growth & Identification ................................................................................................................ 25

5.3 Molecular Identification by *mecA* Gene Amplification ............................................................................. 26

5.4 Statistical Analysis ...................................................................................................................................... 27

Chapter 6: Results .................................................................................................................................................. 30

6.1 Descriptive Statistics .................................................................................................................................... 31

6.2 Participant Group Differences ....................................................................................................................... 34
Chapter 7: Discussion .................................................................................................................. 36

7.1 Conclusions ......................................................................................................................... 36
7.2 Methodological Strengths and Limitations ........................................................................... 37
7.3 Analytical Strengths and Limitations ................................................................................... 39
7.4 Recommendations .............................................................................................................. 40

Chapter 8: Strategic Frameworks .............................................................................................. 41

8.1 Healthy People 2020 ............................................................................................................ 41
8.2 City of El Paso Community Health Assessment ................................................................. 42
8.3 CDC Framework for Preventing Infectious Diseases ......................................................... 42

Chapter 9: MPH Core Competencies ......................................................................................... 44

9.1 Biostatistics ......................................................................................................................... 44
9.2 Epidemiology ..................................................................................................................... 44
9.3 Hispanic and Border Health Concentration .................................................................... 45

References .................................................................................................................................. 46

Appendix 1 .................................................................................................................................... 55
Appendix 2 .................................................................................................................................... 56
Appendix 3 .................................................................................................................................... 57
Appendix 4 .................................................................................................................................... 60
Vita .................................................................................................................................................. 62
List of Tables

Table 2.1: Risk factors for MRSA infection ................................................................. 7
Table 2.2: Differences between HA-MRSA and CA-MRSA ........................................ 11
Table 2.3: Texas DSHS MRSA Statistics ...................................................................... 19
Table 2.4: El Paso Hospitals’ Standardized Infection Ratio for MRSA ........................ 20
Table 5.1: Primer sequences used and expected band sizes. ....................................... 26
Table 6.1: Univariate Analysis Results ........................................................................ 30
List of Figures

Figure 5.1: Methods Process........................................................................................................... 27
Figure 6.1: Positive Culture - Partial mannitol fermentation......................................................... 33
Figure 6.2: Positive Culture - Full mannitol fermentation............................................................ 33
Figure 6.3: PCR Results................................................................................................................. 33
Chapter 1: Introduction

Despite advances in sanitation, disinfection, antimicrobials, and the introduction of new antibiotics over the past few decades, Methicillin-Resistant *Staphylococcus aureus* (MRSA) continues to prevail and burden patients, residents, and communities (Böcher, Gervelmeyer, Monnet, Molbak, & Skov, 2008). Resistance to methicillin was reported in the United Kingdom only two years after the introduction of methicillin in 1959, and resistance rapidly disseminated across the globe, primarily in healthcare settings (Yano et al., 2009). Resistance to methicillin is the result of an altered penicillin-binding protein, PBP2a, encoded by the *mecA* gene. Similar strains have been isolated from healthcare settings around the world and continues to be the culprit of many nosocomial infections worldwide (Cadena, Thinwa, Walter, & Frei, 2016; Dulon, Peters, Schablon, & Nienhaus, 2014; Graffunder & Venezia, 2002; Muder, Brennen, & Goetz, 1993).

Risk factors associated with MRSA infection are similar but slightly different to risk factors associated with MRSA colonization. Previous hospitalization, social deprivation score, surgery, antibiotic use, and MRSA colonization itself were all found to increase the risk of developing an active MRSA infection (Bagger, Zindrou, & Taylor, 2004; Böcher et al., 2008; Cadena et al., 2016; Catry et al., 2014; Graffunder & Venezia, 2002; Gupta, MacIntyre, Vanasse, & Dembry, 2007; Stenehjem & Rimland, 2013; Yano et al., 2009). Factors that increase the risk of becoming a MRSA carrier include a history of MRSA carriage, being a nurse or having an ICU occupation, having contact with MRSA carriers, home-care of relatives, having acne, having chronic inflammatory bowel disease, contact with a domestic animal and with raw meat, and having an acute illness (Sassmannshausen et al., 2016). Similar factors found to increase the risk of developing an active MRSA infection and colonization in an individual’s nares was previous hospitalization within the past year and the use of oral antibiotics (Böcher et al., 2008; Cadena et al., 2016; Graffunder & Venezia, 2002; Hidron et al., 2005).

MRSA strains can colonize at different sites of the body, however it is commonly isolated from the anterior nares. Individuals can be classified into four different statuses that identify their
carriage pattern: Non-carriers, persistent carriers, intermittent carriers and transient carriers (Dulon et al., 2014; Kluytmans J, van Belkum A, & Verbrugh H, 1997). Healthcare workers are most likely to be transiently colonized, colonization during their work shift and the loss of colonization before the start of their next work shift, however, healthcare workers face a greater risk of persistent colonization if they work in an area where there is constant exposure to MRSA (Dulon et al., 2014). Healthcare workers who are colonized and in constant interaction with patients pose a greater risk in transmitting the pathogen to vulnerable patients, such as infants and those who are immunocompromised.

The constant transmission of MRSA in a healthcare setting has been termed Healthcare-Associated MRSA (HA-MRSA). Risk factors for contracting HA-MRSA were the risk factors known to increase the chances of an individual contracting MRSA in general and consisted of hospitalization, surgery, and dialysis (David & Daum, 2010; Huang et al., 2006). By the 1990’s MRSA began burdening communities and infecting people who had no previous risk factors for MRSA. As MRSA rapidly disseminated across communities, Community-Associated MRSA (CA-MRSA) was investigated and was found to be clinically and genetically different than HA-MRSA (Hsiao, Ong, Chuang, Ma, & Huang, 2015). CA-MRSA generally causes skin and soft tissue infections, has greater susceptibility to antimicrobial agents, carry the PVL gene and have different genetic elements than HA-MRSA (Hsiao et al., 2015). CA-MRSA drew attention by infecting otherwise healthy individuals that lacked the common risk factors known for MRSA infection, and by its increasing presence in healthcare settings (David & Daum, 2010).

Treatment of MRSA consists of the administration of oral and intravenous antibiotics, however the specific antibiotic may differ between patients and whether the patient is infected with a HA-MRSA strain or a CA-MRSA strain (PACOSM, 2017). When treating colonized individuals, a decolonization method can be followed to eliminate MRSA that is colonized in the anterior nares. Prevention is key to decreasing MRSA transmission both in a healthcare setting and among community members. Handwashing with soap and water is recommended to avoid transmission of MRSA through contact (Gilboy, 2011; Simor & Loeb, 2004). Healthcare professionals are
encouraged to use proper personal protective equipment and community members are encouraged
to maintain proper wound care and disinfect athletic equipment properly (Gilboy, 2011; Hessen,
2017).

The U.S.-Mexico border area is a region of interest when studying infectious diseases due
to the high mobility of residents crossing the border every single day, with more than 4 million
border crossings per month (Rivera et al., 2009). The border region has a larger percentage of
residents living in poverty, higher unemployment rates and higher fertility rates when compared
to the rest of the United States (Migration Policy Institute, 2006; Pan American Health
Organization, 2012). People in need of medical advice and medical prescriptions cross the border
to obtain services and medication at a much lower price (Homedes & Ugalde, 2012; Rivera et al.,
2009). Such practices result in increased antibiotic consumption, and antibiotic consumption has
been correlated with increasing antibiotic resistance (Homedes & Ugalde, 2012). United States
MRSA statistics demonstrate a slight decrease in the incidence of MRSA, however the
Standardized Infection Ratio (SIR) for hospitals located in El Paso, Texas were much higher than
the state SIR (Medicare, 2017).

This thesis study aims to determine the prevalence of MRSA colonization among first-year
osteopathic medical students at a medical school located at the southern U.S.-Mexico border
region. Due to the fact that medical students most likely have prior healthcare experience, it is
hypothesized the prevalence of MRSA colonization will be higher than the CDC estimate of 2%.
Chapter 2: Background and Significance

2.1 Methicillin-Resistant *Staphylococcus aureus* Infections (MRSA)

2.1.1 Overview

*Staphylococcus aureus* can often be found on different sites of the body while having little to no pathogenicity effect on the host. *S. aureus* is most commonly found on the skin and, in some people, can colonize asymptptomatically in the nose (Hessen, 2017). Although *S. aureus* can be the culprit of a variety of infections, it is usually easily treated and cured by taking oral antibiotics. However, the constant use, misuse, and over-prescription of antibiotics has led to multiple *S. aureus* strains acquiring resistance to a wide variety of antibiotics (Monecke et al., 2011).

Penicillin, which inhibits bacterial cell wall synthesis, was a groundbreaking discovery by Alexander Fleming in 1928 that would eventually allow millions of people to be cured from simple infections previously known to be life threatening (Kong, Schnepfer, & Mathee, 2010). By the 1940’s, penicillin was being offered to the public to treat patients with bacterial infections (Monecke et al., 2011). Within the next decade, the public would experience the first wave of antibiotic resistance, causing penicillin-resistant *S. aureus* to be a global pandemic (Chambers & DeLeo, 2009). The discovery of resistant strains led to the development of the semi-synthetic penicillin’s; methicillin, oxicillin, and cephalosporins (Monecke et al., 2011). Just a year after the introduction of these antibiotics, the United Kingdom reported their discovery of a strain resistant to methicillin, which was later referred to as methicillin-resistant *Staphylococcus aureus* (MRSA) (Monecke et al., 2011). The acquisition of the *mecA* gene, a genetic sequence that confers broad-spectrum beta-lactam resistance to penicillins, cephalosporins and carbapenems, is responsible for converting regular *S. aureus* to MRSA, also known as Oxicillin-Resistant *Staphylococcus aureus* (ORSA) (Chambers & DeLeo, 2009; Monecke et al., 2011).
MRSA can exhibit resistance to multiple antibiotics through multiple mechanisms. The original *S. aureus* mechanism of resistance to beta-lactam antibiotics was through the action of the beta-lactamase enzyme, which hydrolyzes the beta-lactam ring (Fishovitz, Hermoso, chang, & Mobasherry, 2014). When beta-lactamase containing organisms were introduced to methicillin, they were susceptible to the antibiotic and effectively treated. When methicillin resistance arose, it was soon discovered to be the result of a different resistance mechanism. Thus, the mechanism of interest is through the action conferred by the *mecA* gene. Methicillin is effective by inhibiting the activity of penicillin binding proteins (PBP). Penicillin binding proteins are members of a group of enzymes known as transpepdidases. Transpepdidases are responsible for cross-linking the peptidoglycan layer during bacterial cell wall synthesis. Therefore, when penicillin binds to penicillin binding proteins, it inhibits bacterial cell wall synthesis resulting in a weak cell wall that will eventually rupture (Fishovitz et al., 2014). The *mecA* gene encodes for a penicillin binding protein (PBP) known as PBP2a. While methicillin has the ability to inhibit all other PBP’s, PBP2a has a low affinity for methicillin and continues cross-linking the bacterial cell wall, rendering penicillin to be ineffective (Fishovitz et al., 2014). The *mecA* gene is important because it has the ability to be horizontally transferred to other strains, allowing for the widespread of resistance. The *mecA* gene is encoded on a mobile genetic element known as the Staphylococcal Cassette Chromosome mec (SCC mec) (Wielders, Fluit, Brisse, Verhoef, & Schmitz, 2002). It is not yet known where the *mecA* gene came from initially, however, it is believed to be horizontally transferred from a strain resistant to methicillin to strains susceptible to methicillin, allowing the resistance to actively spread.
2.1.2 Risk Factors

Poverty has long been associated with an increased risk of infectious disease acquisition and transmission. Effective sanitation and hygiene techniques efficiently reduced the burden of infectious disease prior to the development of antibiotics. However, with the use of antimicrobials and effective sanitation, disinfection, and hygiene practices in today’s society, infectious diseases continue to prevail. There are multiple reasons as to why MRSA infections emerge and why some people are more likely to become colonized carriers of MRSA and others are not.

MRSA Infection

The emergence of MRSA infections can be due to several factors including social factors and environmental settings. Several studies reported previous hospitalization as a risk factor for the development of active MRSA infections (Böcher et al., 2008; Cadena et al., 2016; Graffunder & Venezia, 2002), while other studies attributed a longer length of stay in the hospital due to the emergence of a MRSA infection (Yao et al., 2015). In regard to social factors, Bagger et al. reported that post-operative MRSA infection was associated with social deprivation score, and members from the most socially deprived areas were seven times more likely to acquire an infection compared to members of the least socially deprived areas (Bagger et al., 2004). In addition, women were over two times more likely to acquire a post-operative MRSA infection (Bagger et al., 2004). Surgery itself has been reported to be a risk factor for MRSA infections as well (Cadena, Thinwa, Walter, & Frei, 2016; Graffunder & Venezia, 2002). In many cases, following hospital admission and surgical procedures, it is common practice to prescribe oral antibiotics. The prescription and recent use of antibiotics is also considered a risk factor for the development of a MRSA infection by multiple authors (Böcher et al., 2008; Catry et al., 2014; Graffunder & Venezia, 2002). Additional risk factors for MRSA infection include underlying skin
diseases, enteral feedings, use of a respirator, admission to long term care settings, and the use of antimicrobial agents (Böcher et al., 2008; Catry et al., 2014; Graffunder & Venezia, 2002; Yao et al., 2015). Lastly, a significant risk factor for MRSA infections is colonization and nasal carriage of MRSA (Cadena et al., 2016; Gupta et al., 2007; Stenehjem & Rimland, 2013; Yano et al., 2009). Yano et al. (2009) found that patients colonized with MRSA had a significantly higher occurrence of post-operative surgical site infection with MRSA than patients who were not colonized (Yano et al., 2009). Cadena et al. (2016) found that MRSA colonization led to an increased risk of MRSA skin soft tissue infections following hospitalization (Cadena et al., 2016). A summary of the risk factors associated with MRSA infections can be found on Table 2.1.

Table 2.1: Risk factors for MRSA infection

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Reference(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous Hospitalization</td>
<td>(Graffunder &amp; Venezia, 2002)</td>
</tr>
<tr>
<td></td>
<td>(Böcher et al., 2008)</td>
</tr>
<tr>
<td></td>
<td>(Cadena et al., 2016)</td>
</tr>
<tr>
<td>Social Deprivation Score</td>
<td>(Bagger et al., 2004)</td>
</tr>
<tr>
<td>Surgery</td>
<td>(Cadena, 2016)</td>
</tr>
<tr>
<td></td>
<td>(Graffunder, 2002)</td>
</tr>
<tr>
<td>Antibiotic Use</td>
<td>(Graffunder &amp; Venezia, 2002)</td>
</tr>
<tr>
<td></td>
<td>(Böcher et al., 2008)</td>
</tr>
<tr>
<td></td>
<td>(Cary et al., 2014)</td>
</tr>
<tr>
<td>MRSA Colonization</td>
<td>(Yano, 2009)</td>
</tr>
<tr>
<td></td>
<td>(Stenehjem &amp; Rimland, 2013)</td>
</tr>
<tr>
<td></td>
<td>(Gupta et al., 2013)</td>
</tr>
<tr>
<td></td>
<td>(Cadena, 2016)</td>
</tr>
</tbody>
</table>
**MRSA Colonization**

The recent rise of MRSA colonization has led to further investigation of the risk factors that can cause individuals to become MRSA carriers, with the potential of developing a life-threatening infection later in life. Similar to the risk factors for MRSA infection, hospitalization within the past twelve months, a skin infection at the time of hospital admission, antimicrobial use, and being HIV positive have all been reported to be risk factors for MRSA colonization (Hidron et al., 2005). Hospitalization within the past year was also found to be a risk factor for MRSA colonization in two of the papers written by Jernigan et al. (2003), in conjunction with admission to a long-term living facility, specifically a nursing home, and the presence of at least one underlying chronic illness (Jernigan, Pullen, Partin, & Jarvis, 2003). Sassmannshausen et al. (2016) found additional risk factors for MRSA colonization that consisted of: a history of MRSA carriage, being a nurse or having an ICU occupation, having contact with MRSA carriers, home-care of relatives, having acne, having chronic inflammatory bowel disease, contact with a domestic animal and with raw meat, and having an acute illness (Sassmannshausen et al., 2016). MRSA colonization has many risk factors different from MRSA infection, however, hospitalization within the previous year and antimicrobial use play a significant role in increasing the risk of both MRSA infections and MRSA colonization.

2.1.3 MRSA Nasal Colonization

MRSA nasal colonization is the carriage of MRSA in the anterior nares, usually asymptptomatically. Although colonization can occur at other sites of the body such as the hands, skin, underarms and intestinal tract, colonization in the nares has been found to be more consistent when isolating MRSA (Dulon et al., 2014; Kluytmans J et al., 1997). MRSA and susceptible *S. aureus* have an increased ability to adhere to the epithelial cells in the nares, in addition to the nose
providing an environment where the organism can proliferate and survive for prolonged periods of time (Kluymans J et al., 1997). There are currently four different statuses identified and are used to classify individuals based on their carriage: 1) Non-carriers, 2) persistent carriers, 3) intermittent carriers and 4) transient carriers. Persistent carriers are individuals who chronically carry only one strain, intermittent carriers are individuals who carry different strains for short time periods, and non-carriers who almost never carry *S. aureus* at all (Dulon et al., 2014). Statuses can often change within an individuals’ life-time, and most individuals’ pattern of carriage changes when they are between the ages of ten and twenty (Kluymans et al., 1997). Health-care workers who may constantly be exposed to MRSA can become carriers during or after a work shift and lose carriage of the pathogen before the next shift, these health-care workers are considered to be transient carriers (Dulon et al., 2014). If a health-care worker has chronic dermatitis or sinusitis, their chances of becoming persistent carriers increases, however most health-care workers fall within the transient carriage status (Dulon et al., 2014).

Colonization with MRSA has consistently been found to increase the risk of developing an active MRSA infection. When colonization in the nares occurs, it allows for the pathogen to spread to other sites of the body (Kluymans et al., 1997). In health-care settings, colonization in health-care workers becomes increasingly significant because they become a potential source for transmission to patients who may or may not be immune-suppressed and can increase the chance of a patient developing a MRSA infection. Health-care workers who work in units with constant exposure to MRSA are more likely to be colonized with MRSA (Muder et al., 1993). Although health-care workers are likely to be transiently colonized, they may serve as vectors in the transmission of MRSA (Dulon et al., 2014). The CDC estimates 33% of people carry susceptible
S. aureus in their anterior nares, and about 2% of the population can be colonized with MRSA (Centers for Disease Control and Prevention, 2017).

2.1.4 HA-MRSA & CA-MRSA

Healthcare-associated or Hospital-associated MRSA are MRSA strains that are typically transmitted and acquired in a health-care setting. Risk factors for HA-MRSA infections include hospitalization, residence in a nursing home or other long-term care facility, surgery, dialysis, and the presence of a foreign device such as a catheter (David & Daum, 2010; Huang et al., 2006). HA-MRSA are known to be resistant to multiple antibiotics including non-beta-lactam antibiotics through the genetic elements type II and type III staphylococcal cassette chromosomes (SCCmec II-III) (David & Daum, 2010). Common variants of HA-MRSA strains include USA100 and USA200. MRSA was identified in the 1960’s and was associated with the health-care setting, however in the mid 1990’s MRSA outbreaks were being observed in communities affecting healthy patients and people lacking risk factors known to be associated with MRSA (David & Daum, 2010; Hsiao et al., 2015). It was soon discovered the strains responsible for community MRSA outbreaks are distinctively different than HA-MRSA and were termed Community-associated MRSA (CA-MRSA). CA-MRSA are genetically different than HA-MRSA. While HA-MRSA contain SCCmec II-III, CA-MRSA contain SCCmec IV and V, and in addition, carry the Panton Valentine gene (PVL) (Hsiao et al., 2015). The PVL gene is a virulence factor responsible for the production of a cytotoxin that can cause tissue necrosis and leukocyte destruction (Adler, Temper, Block, Abramson, & Moses, 2006). The most common variants of CA-MRSA are strains USA300 and USA400. HA-MRSA affects patients in long-term care facilities, who have recently been hospitalized and those who have undergone surgery, however, CA-MRSA affects young and healthy people usually in the form of skin and soft tissue infections who have not been exposed to
the health-care setting at all (Huang et al., 2006). Most infections caused by CA-MRSA are not as resistant and difficult to treat as many HA-MRSA and are susceptible and treated with weaker antibiotics than HA-MRSA infections (Hsiao et al., 2015). The differences between HA-MRSA and CA-MRSA can be seen on Table 2.2. The emergence of CA-MRSA has drawn attention due to its ability to rapidly disseminate across communities and entering the health-care setting, replacing HA-MRSA strains and being transmitted within the hospital environment (David & Daum, 2010).

Table 2.2: Differences between HA-MRSA and CA-MRSA

<table>
<thead>
<tr>
<th>Healthcare-Associated MRSA</th>
<th>Differences</th>
<th>Community-Associated MRSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthcare/Hospital setting</td>
<td>Acquisition</td>
<td>Community Setting</td>
</tr>
<tr>
<td>Hospitalization, residence in a long-term</td>
<td>Risk Factors</td>
<td>Close contact with community members</td>
</tr>
<tr>
<td>care facility, surgery, dialysis, presence</td>
<td></td>
<td>Skin and soft tissue infections</td>
</tr>
<tr>
<td>of foreign device (catheter)</td>
<td></td>
<td>Poor hygiene</td>
</tr>
<tr>
<td>High resistance to multiple antibiotics</td>
<td>Resistance</td>
<td>Not as resistant</td>
</tr>
<tr>
<td>SCCmec II &amp; III</td>
<td>Genetic Elements</td>
<td>SCCmec IV &amp; V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Panton Valentine gene (PVL)</td>
</tr>
<tr>
<td>Vancomycin, Daptomycin, Linezolid, Tigecycline</td>
<td>Treatment</td>
<td>Doxycycline, Clinamycin, Bactrim</td>
</tr>
<tr>
<td>USA100 &amp; USA200</td>
<td>Variants</td>
<td>USA300 &amp; USA400</td>
</tr>
</tbody>
</table>

2.1.5 Treatment and Prevention

Due to MRSA’s resistant and highly pathogenic nature, treatment of MRSA is often challenging, costly and aggressive. Treatment of MRSA includes incision and drainage of the
abscess, if treating a skin and soft-tissue infection (Gilboy, 2011). In addition, surgical debridement may be necessary to remove dead tissue of the abscess (Hessen, 2017). Medications used to treat MRSA include antibiotics, both intravenous (IV) and oral, and some oils as well as clay have been found to be effective against MRSA and can be used as a non-drug therapy to treat MRSA infections. The first line of IV therapy is Vancomycin but also includes daptomycin, linezolid, tigecycline, and quinupristin/dalfopristin (Gilboy, 2011; Hessen, 2017; Simor & Loeb, 2004). Oral antibiotics can also be used to treat MRSA and include trimethoprim-sulfamethoxazole (TMP-SMX), clindamycin, tetracycline/doxycycline/minocycline, linezolid and rifampin (Gilboy, 2011; Simor & Loeb, 2004; Hessen, 2017). Each antibiotic is different, requires different dosages, and is administered for different time periods. When a MRSA infection involves a foreign body, such as a prosthesis, the foreign body may have to be removed in addition to administering antibiotics. Non-drug therapies that have been studied and observed to inhibit growth and combat MRSA include lemongrass essential oil, tea-tree oil, and French clay (Gilboy, 2011). Patients infected with HA-MRSA often require more aggressive therapy than patients infected with CA-MRSA, this is due to the differences in genetic elements that cause HA-MRSA to confer higher resistance. Vancomycin is usually the first-line of treatment for HA-MRSA infections but can also be treated with Daptomycin, Linezolid, and Tigecycline. CA-MRSA infections are often treated with Doxycycline, Clindamycin and Bactrim, along with educating the patient on wound care and proper hygiene (PACOSM, 2017).

When treating patients nasally colonized with MRSA, decolonization is not strongly advised or enforced. In certain circumstances such as being a health-care worker and having close contact with immunocompromised patients, being immunocompromised, and living in institutions such as mental institutions and prisons, decolonization may be advisable (Gilboy, 2011). One
method of decolonization is by washing with chlorhexidine or hexachlorophene if used in conjunction with mupirocin (Gilboy, 2011). Placing mupirocin in the nostrils twice or thrice daily for seven or six days has also been proven to be effective in decolonization of MRSA (Gilboy, 2011; Sassmannshausen et al., 2016).

Clinicians, health-care workers and community members must take proper precautions in order to avoid and halt the transmission of MRSA. Clinicians often use hand sanitizer or antibacterial solutions to clean their hands between patient visits, however, it is recommended to wash hands properly with soap and water in between patient visits to effectively clean their hands and avoid transmitting the agent to other patients (Gilboy, 2011; Simor & Loeb, 2004). In addition to hand washing in between patients, the use of hand gloves are recommended to use when coming in contact with patients and are to be removed immediately after the interaction to avoid the transmission of infectious agents (Gilboy, 2011). If necessary, additional personal protective equipment may be used such as disposable gowns, masks and eye protection (Gilboy, 2011). In health-care settings, effective screening and surveillance techniques are recommended to identify persistent MRSA carriers, and decolonization efforts are suggested (Simor & Loeb, 2004). In community settings, proper disinfection and sanitation of athletic equipment and the proper care of wounds is recommended, in addition to precautionary measures when someone in the community acquires a MRSA infection (Hessen, 2017).

2.2 U.S./Mexico Border Region

2.2.1 Definition and Characteristics

The U.S.-Mexico border region is defined by U.S. Public Law and the La Paz Agreement of 1983 as the area comprising 62 miles north and south of the border, extending over 2,000 miles
long from California to the Gulf of Mexico (Rivera et al., 2009; Velasco, 2014). The border region consists of 44 U.S. counties and four U.S. states, California, New Mexico, Arizona and Texas, and 80 Mexican municipalities along with six Mexican states, Baja California, Sonora, Chihuahua, Nuevo Leon, and Tamaulipas (Velasco, 2014).

The border region is home to about 15 million residents living on both sides of the border (Pan American Health Organization, 2012). Approximately 25% of residents living in U.S. border counties fall at or below the poverty line, which is more than double for the national average of 12% of people living in poverty (Migration Policy Institute, 2006). In addition, unemployment rates are higher in the U.S. border area, 5.6%, compared to the rest of the United States, 4.7% (Migration Policy Institute, 2006). However, Mexican states located on the border region have a much lower poverty percentage of 28%, compared to the Mexican national average of 37% (Migration Policy Institute, 2006). Due to high fertility in the border region, the population of both sides of the border is relatively young with 30% of the Mexican border population and 24% of the U.S. border population being under 15 years old (Pan American Health Organization, 2012). Life expectancy on both sides of the border is about 3% above the average of both countries (Pan American Health Organization, 2012).

Thousands of border crossings occur on a day-by-day basis for various reasons. Border crossings continue to fluctuate throughout the years, rising by 43% from 1995 to 1999, and falling 21% by 2004, then rising again by 63% in 2006 (Pan American Health Organization, 2012; Migration Policy Institute, 2006). Due to the frequent high mobility across the U.S.-Mexico border, the border region faces unique health challenges and disparities that disproportionally affect the border area compared to the rest of the United States and Mexico. Maternal mortality rates continue to be higher in the border region when compared to national averages, with Texas
having the highest maternal mortality rates, 22.2% in 2008, compared to the national average of 12.7% and 62.9% of maternal deaths in Chihuahua for the year 2008 compared to the Mexican national average of 59.7% (Pan American Health Organization, 2012). The number one cause of death in both the Mexican side of the border region and the United States side is diseases of the heart (Pan American Health Organization, 2012). Right below diseases of the heart, malignant neoplasms at number two and diabetes Mellitus at number 6 in the U.S. and number 3 in Mexico follow (Pan American Health Organization, 2012). The border health commission identified six strategic priorities which included access to care, tuberculosis, obesity and diabetes, and infectious diseases (Velasco, 2014).

Vector borne diseases, sexual transmitted diseases and infectious diseases such as tuberculosis continue to prevail and cause concern in the border region. In 2010, of all West Nile virus cases that occurred throughout the United States, 40% of the cases occurred in the four border states (Pan American Health Organization, 2012). The incidence rate in Arizona and Texas for HIV/AIDS were significantly high in 2009, being 10.2 cases per 100,000 population in Arizona and 17.1 cases per 100,000 population in Texas. Congenital syphilis incidence rates were highest in the Mexican border region in 2010 when compared to the rest of Mexico, 30 cases per 100,000, and highest in Texas at 25.3 per 100,000 population when compared to the rest of the United States (Pan American Health Organization, 2012). Tuberculosis incidence rates were highest in California in 2009 with 6.7 new cases per 100,000 population, followed by Texas with 6.1 new cases of tuberculosis per 100,000 population (Pan American Health Organization, 2012). Baja California reported having an incidence rate of 38.3 per 100,000 population compared to the national average of 13.5 (Pan American Health Organization, 2012). In response to the many illnesses that prevail in the border region, both infectious and chronic, access to health care
continues to be a major reason to cross the U.S.-Mexico border every single day for millions of people (Rivera et al., 2009).

2.2.2 Antibiotic Resistance and Consumption

Antibiotic resistance has burdened and interfered with treatment of patients since antibiotics were first introduced to the public in the 1940’s. The development of new antibiotics has aided in combatting resistant organisms only slightly. The mechanisms of resistance change at a pace too fast for antimicrobial therapy to catch up. Emerging resistance mechanisms have primarily been attributed to antibiotic overuse and inappropriate prescribing, as well as its heavy use in agriculture (Ventola, 2015). Chambers and DeLeo describe the history of *S. aureus* antibiotic resistance in four “waves.” The first wave of resistance occurred when *S. aureus* grew resistant to penicillin through the plasmid-encoded penicillinase (Chambers & DeLeo, 2009). The second wave of *S. aureus* resistance occurred 20 years later with the first published report of resistance to methicillin through the action of PBP 2a (Chambers & DeLeo, 2009). In response to the overwhelming presence of HA-MRSA in health-care settings, the use of vancomycin surged and in result, vancomycin-resistance *S. aureus* (VRSA) appeared marking the beginning of the third wave of resistance (Chambers & DeLeo, 2009). The final and current wave of *S. aureus* resistance is due to the rapid spread of MRSA in communities, as previously described in section 2.1.4.

The emergence of these waves of resistance have continuously burdened the health-care system making infections harder to treat, while increasing cost and length of hospitalization for patients (Vonberg et al., 2006). Antimicrobial resistance has demonstrated its ability to rapidly disseminate across communities and is considered a global threat to public health (Gartin, Brewis, & Schwartz, 2010). The high mobility of people crossing the US/Mexico border, specifically the
El Paso/Cd. Juarez border, on a daily basis cause a greater risk for infections and resistant organisms to be transmitted in both directions (Rivera et al., 2009). In addition, many Mexican residents and U.S. residents cross the border to obtain health care and pharmaceuticals. When many U.S. patients cannot afford or obtain antibiotics on the U.S. side of the border, obtaining them from Mexico is an often cheap and feasible strategy (Homedes & Ugalde, 2012). Until recently, obtaining antibiotics from Mexican pharmacies was possible without a prescription, resulting in the common practice of self-medication (Gartin et al., 2010). Now that antibiotics is considered a controlled substance in Mexico, the problem has only slightly improved but has not completely been eliminated.

Anyone can open and own a pharmacy and does not necessarily have to be a physician, and the dispensing of antibiotics to patients who do not have prescriptions is not well controlled (Homedes & Ugalde, 2012). In addition to dispensing pharmaceuticals, some Mexican pharmacists who receive limited training can diagnose patients and prescribe medications for a small fee (Homedes & Ugalde, 2012). Antibiotics continue to be one of the most sold pharmaceuticals on both sides of the border supporting the assumption that over-prescription, over-dispense, and over-consumption continues to be an obstacle in fighting emerging antibiotic resistance. El Paso faces a greater risk to emerging antibiotic resistance due to its geographical location, as it sits right next to Mexico and has the largest U.S./Mexico border population (Rivera et al., 2009).

2.2.3 MRSA Infection Statistics
United States

The Center for Disease Control and Prevention (CDC) has an Emerging Infections Program (EIP) that tracks the national burden of MRSA using data from six states, California, Connecticut, Georgia, Minnesota, New York, and Tennessee (Centers for Disease Control and Prevention, 2015). The most recent data tracks MRSA cases up until 2015, and reports the amount of cases that were community-associated and hospital-associated. Healthcare-associated cases (HCA), 2,117, were significantly higher than community-associated (CA), 560, with healthcare-associated community onset cases (HACO), 1,678, outweighing hospital-onset cases (HO), 493 (CDC, 2015). Out of the 2,117 HCA infections, 279 (13%) resulted in deaths, while only 53 cases (9%) of the 560 CA cases resulted in deaths. The most frequent clinical syndrome associated with MRSA infections among CA and HACO cases was bloodstream infection with other syndrome (CDC, 2015). The most frequent clinical syndrome among HO cases was bloodstream infection with no other syndrome. The second most frequent syndrome in CA cases was cellulitis (CDC, 2015). HACO and CA cases were highest among individuals greater than 65 years of age, while HO cases were highest among infants less than 1 year of age. Comparing the data to 2014, the overall incidence of healthcare-associated MRSA decreased by 10% (CDC, 2015).

Texas

The Texas Department of State Health Services (DSHS) has MRSA statistics available from 2012 to 2014 but state their data is limited. Table 2.2 illustrates the data obtained from the Texas DSHS.
According to the data provided by the Texas DSHS, although the amount of *S. aureus* isolates decreased from 2013 to 2014, overall MRSA percentage has been steadily increasing (Texas Department of State Health Services, 2017).

Through the CDC’s National Healthcare Safety Network, Healthcare-associated infections are tracked and reported by state. The Texas report includes several healthcare-associated infections including MRSA bacteremia based on 2014 data. The total amount of hospitals included in the Texas healthcare-associated infections report was 372 hospitals. From 2013 to 2014, Texas hospitals reported no significant change in MRSA bacteremia (Centers for Disease Control and Prevention, 2016). The standardized infection ratio (SIR) for U.S. was calculated to be 0.87, and among the 163 Texas hospitals with enough data to calculate an SIR, 7% had an SIR significantly worse than the national SIR (CDC, 2016). However, the 2014 state SIR was 0.83, slightly lower than the national average and 0.04% lower than the 2013 state SIR (CDC, 2016).

### Table 2.3: Texas DSHS MRSA Statistics

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of S. aureus isolates</th>
<th>No. (%) of MRSA isolates</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>609 isolates</td>
<td>274 isolates (45%)</td>
</tr>
<tr>
<td>2013</td>
<td>790 isolates</td>
<td>438 isolates (55.45%)</td>
</tr>
<tr>
<td>2014</td>
<td>710 isolates</td>
<td>395 isolates (55.67%)</td>
</tr>
</tbody>
</table>

*El Paso*

In order for hospitals to obtain payment from Medicare, Medicare requires hospitals to submit data on healthcare-associated infections and then allows customers to access the data through their website, medicare.gov, in order to be used to compare different hospitals of interest. Medicare considers the Texas SIR rate to be 0.886, and compares the hospitals to that number. El
Paso hospitals’ SIR for laboratory-identified MRSA bloodstream infections can be found on Table 2.3.

Table 2.4: El Paso Hospitals’ Standardized Infection Ratio for MRSA

<table>
<thead>
<tr>
<th>Hospital Name</th>
<th>Hospital SIR</th>
<th>Texas SIR^a</th>
</tr>
</thead>
<tbody>
<tr>
<td>University Medical Center of El Paso</td>
<td>1.177</td>
<td>0.886</td>
</tr>
<tr>
<td>Las Palmas Medical Center</td>
<td>1.225</td>
<td></td>
</tr>
<tr>
<td>The Hospitals of Providence Memorial Campus</td>
<td>0.268</td>
<td>0.886</td>
</tr>
<tr>
<td>Sierra Providence East Medical Center</td>
<td>1.083</td>
<td></td>
</tr>
</tbody>
</table>

^a According to Medicare.gov

The hospitals with available data were included in Table 2.3. Three of the four hospitals’ SIR for laboratory-identified MRSA bloodstream infections were above the state SIR of 0.886 (Medicare, 2017).

O’Brien et al. (2005) studied multiple-antibiotic-resistant MRSA isolates obtained from Las Palmas and Del Sol medical center of El Paso during June to August of 2002. Using a disk diffusion assay the MRSA isolates resistant to three or more classes of antibiotics were considered to be multiple-antibiotic-resistant MRSA clones (O’Brien et al., 2005). The study concluded by stating there is a presence of a multiple-antibiotic-resistant MRSA epidemic in El Paso, Texas (O’Brien et al., 2005). According to a study investigating the prevalence of MRSA on both sides of the El Paso/Cd. Juarez border, El Paso had a significantly higher prevalence of MRSA when compared to Juarez, and over a third of the MRSA isolates were community-associated (Rivera et al., 2009). Benoit et al. studied antimicrobial resistance trends using eight hospitals in three states at the U.S.-Mexico border from 2000 to 2006. Six different pathogens were studied, however of the six pathogens, resistance was highest among *S. aureus* isolates with 45.7% of all *S. aureus* isolates being resistant to oxacillin (Benoit, Ellingson, Waterman, & Pearson, 2013). The majority
of MRSA isolates were isolated from skin and soft tissue infections, and significantly increased from 14% in 2000, to 65.6% in 2006 which indicates an increasing presence of CA-MRSA at the border region (Benoit et al., 2013).
Chapter 3: Goal and Objective

3.1 Goal and Objective

The goal of this project is to determine the prevalence of *S. aureus* and MRSA nasal colonization among first-year medical students, at an osteopathic school of medicine located in the Southern U.S./Mexico Border region. The objective of this project is to establish the carrier status of first-year osteopathic medical students by conducting nasal swabs on the participants and characterizing the bacteria through selective media and *mecA* gene amplification.
Chapter 4: Study Aims and Hypothesis

4.1 Aims

Aim 1: Examine the risk factors associated with Methicillin-Resistant *S. aureus*.

Aim 2: Identify the prevalence of *S. aureus* and MRSA nasal carriage among incoming medical students by obtaining nasal swabs, culturing the swabs, and performing PCR.

4.2 Hypothesis

Hypothesis: The prevalence of students colonized with MRSA will be higher than the CDC estimate of 2% of the population due to students having greater amounts of previous healthcare exposure hours.
Chapter 5: Methods and Materials

5.1 Sample Collection & Recruitment

This research project is in collaboration with Burrell College of Osteopathic Medicine (BCOM). The study aims to recruit incoming first-year medical students attending (BCOM), willing to participate throughout their four years in medical school, and non-medical graduate students attending New Mexico State University (NMSU) to serve as controls. The study is a cohort, longitudinal study, and data will be collected once a year for four years. A nasal swab and a survey will be obtained from the participants, beginning November of 2017 and every year thereafter. BCOM researchers conducted a power analysis to calculate the sample size needed to have a representative sample and resulted in a minimum of 41 participants, however, the study aims to recruit a total of 82 participants to maintain the integrity of the study.

The subject participants were recruited during their school’s new student orientation and were given a presentation about the study. Burrell College of Osteopathic Medicine’s Institutional Review Board reviewed and approved the proposed protocol #BCOM IRB 00012_2017 entitled “Rate of MRSA Acquisition in Medical Students from Pre-Clinical to Clinical Years” (Appendix 1). All participants were given a participant survey to complete (Appendix 4). The medical students who agreed to participate in the study were added to their institution’s Canvas Learning Management System’s online course created specifically for the study, where they will electronically complete the survey. After completing the survey, participants were assigned a random four-digit number. Study participants arranged a date with investigators to have nasal swabs performed and where informed consent forms were signed (Appendix 3). The nasal swabs were then labeled with the participant’s assigned number. Recruitment and sample collection was conducted by the BCOM research team. The control participants were recruited during a graduate
school meeting where they signed the consent form, completed the participant survey, and nasal swabs were obtained. UTEP did not have any interaction with study participants or collection of nasal swabs. Due to the samples and survey results being de-identified before arriving at UTEP, UTEP’s protocol is exempt and relies on BCOM’s IRB (Appendix 2).

Nasal swabs were transported to Dr. Dominguez laboratory at the college of Health Sciences immediately after collection. The nasal swabs were then cultured on selective media and characterized phenotypically and molecular techniques were used to detect the gene associated with MRSA strains.

5.2 Bacterial Growth & Identification

The media used to culture the nasal swabs was Mannitol Salts Agar (MSA), which is a selective medium for the isolation of S. aureus (Sigma-Aldrich’s). The high concentration of salt in MSA media supports the growth of Staphylococcus species, while inhibiting the growth of many other organisms (EMD Millipore). S. aureus will produce yellow colonies and turn the phenol red agar yellow by fermenting the mannitol and is the first indication of S. aureus (EMD Millipore). The swabs used for the nasal swabbing were directly used to streak for isolation on the MSA media. Cultures were incubated at 35°C for 24-48 hours to allow for sufficient growth. Yellow colonies were subcultured onto Trypticase Soy Agar (TSA) in order to allow for sufficient growth in order to store the organisms in Microbank Beads Bacterial Preservation Systems (Pro-Lab Diagnostics™). Since other Staphylococci species may produce a clumping factor, a tube coagulase test was performed to confirm identification of S. aureus using BBL Coagulase Plasma, Rabbit with EDTA (Beckton, Dickinson and Company). If the organism produced Staphylocoagulase, an extracellular molecule that causes clot formation, a positive reaction would be demonstrated by a development of a clot. The DNA of the positive organisms was then
extracted, and PCR was performed. A representation of the methods process can be seen in Figure 5.1.

5.3 Molecular Identification by mecA Gene Amplification

5.3.1 DNA Extraction

One Microbank bead was inoculated into 10ml of Luria Broth and placed in the shaker overnight at 35°C. After 18 hours, the DNA of the organism was extracted using Qiagen’s DNeasy Blood and Tissue kit according to the manufacturer’s instructions for gram-positive bacteria (Qiagen Inc., Valencia, CA). The integrity of the extracted DNA was assessed by electrophoresis at 140V on a 1% agarose gel for 30 minutes. DNA was visualized by Ethidium Bromide (0.5µl).

5.3.2 Polymerase Chain Reaction (PCR)

Polymerase Chain Reaction (PCR) was performed to amplify the mecA gene. Table 5.1 illustrates the forward and reverse primers that were used (Al-Haddad, Udo, Mokadas, Sanyal, & Grubb, 2001). Cycling parameters were as follows: 1 cycle denaturation 94°C for 1 minute, annealing 55°C for 30 seconds, and extension72°C for 90 seconds, 30 cycles(Al-Haddad et al., 2001). S. aureus ATCC 29213 and E. coli ATCC 25922 were used as negative controls and S. aureus ATCC 43300 was used as a positive control along with the universal primer 16S rDNA as the internal control (Rivera et al., 2009). The PCR product was visualized on a 2% agarose gel through electrophoresis at 140V for 60 minutes with 0.5µl of Ethidium Bromide.

<table>
<thead>
<tr>
<th>Primer</th>
<th>Sequence (5’-3’)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>mecAfw</td>
<td>AAAATCGATGGTAAAGGTTGGC</td>
<td>(Al-Haddad et al., 2001)</td>
</tr>
<tr>
<td>mecArv</td>
<td>AGTTCTGCAGTACC GGATTTGC</td>
<td>(Al-Haddad et al., 2001)</td>
</tr>
</tbody>
</table>
Figure 5.1: A visual representation of the methods process.

5.4 Statistical Analysis

The survey administered to participants was developed by BCOM researchers and asked participants to provide information about their demographics, social characteristics, and medical history (Appendix 4). In the demographics section, the participants were asked to provide their name and age, whether they were osteopathic medical students year one, two, three or four, and to identify their ethnicity as one of the following: African American, Hispanic, Caucasian, Asian,
Indian, Native American, or Other. Under social data, participants were asked to provide their living situation which included: living alone, in a dorm with other medical students, in a dorm with other non-medical students, with family, with others, homeless, or other. Participants were asked whether they live with children under the age of 18, whether they have a dog or cat at home, or if they have frequent contact with livestock such as cows, pigs, sheep or chickens. Participants were asked whether they smoke daily or use any tobacco products and the frequency of such use, if they care for a chronically-ill person at home, if they are currently employed, if they have prior healthcare experience, and if so, participants were asked to describe and/or list those experiences.

Under the medical history section of the survey, participants were asked if they have any health problems, if they are currently on a steroid regimen, and if they’ve taken steroids within the past three weeks. Participants were asked if they have taken antibiotics within the past six months, if so, they were asked to list the antibiotics taken, and if they always finish the entire course of antibiotics when prescribed. Participants were then asked if they have been hospitalized within the past six months, if they have had surgery within the past six months, if they have ever had a skin infection, if they have ever been diagnosed with a MRSA infection, if they have ever had a respiratory infection or pneumonia, and if they are currently ill.

The survey data was obtained from BCOM’s research team free of any personal identifiers in the form of a comma-separated value (CSV) file. The data was imported into the statistical software Statistical Package for Social Sciences (SPSS) and separate columns were added to include the results of the nasal swab culture, coagulase test, and PCR analysis. The responses obtained for the question labelled “Ethnicity” were recoded into two separate variables, Race and Ethnicity. The levels used for the Race variable were obtained from the U.S. Census Bureau (U.S. Department of Commerce, Economics and Statistics Administration, January 2017) and included
White, Black/African American, American Indian/Alaska Native, Asian, Native Hawaiian/Pacific Islander, and Other. Participants who stated their Ethnicity to be White, Caucasian, Hispanic, Latino, Pakistani, and White Middle Eastern were identified as White. Participants who stated their ethnicity as Asian Caucasian, White Asian, Taiwanese, Filipino American, and Chinese were identified as Asian. Participants who stated their ethnicity to be Peruvian and Mexican were identified as American Indian/Alaska Native. The levels for Ethnicity were obtained from the U.S. Census Bureau (U.S. Department of Commerce, 2017) and included Non-Hispanic/Latino, and Hispanic/Latino. Participants who explicitly stated their ethnicity to be Hispanic, Latino, Mexican, or Peruvian were considered as Hispanic/Latino. All other participants were identified as Non-Hispanic/Latino.

A univariate analysis was conducted for each variable. For continuous variables that are normally distributed, the sample size (n), mean, and standard deviation (SD) were reported. For continuous variables that are not normally distributed, the sample size (n), minimum, Q1, median, Q3, and maximum were reported. For categorical variables, the sample size, frequency and percentages were reported.
Chapter 6: Results

The results in Table 6.1 display the results obtained for the univariate analyses. The results are separated into four categories, sociodemographic characteristics, social characteristics, medical history, and laboratory results.

Table 6.1: Univariate Analysis Results

<table>
<thead>
<tr>
<th>PARTICIPANT SURVEY QUESTIONS</th>
<th>ALL PARTICIPANTS</th>
<th>SUBJECTS ONLY</th>
<th>CONTROLS ONLY</th>
</tr>
</thead>
<tbody>
<tr>
<td>N Mean SD Missing (freq)</td>
<td>N Median (Q1, Q3) Missing (freq)</td>
<td>N Mean SD Missing (freq)</td>
<td>N Median (Q1, Q3) Missing (freq)</td>
</tr>
<tr>
<td>N Freq % Missing (freq)</td>
<td>N Freq % Missing (freq)</td>
<td>N Freq % Missing (freq)</td>
<td>N Freq % Missing (freq)</td>
</tr>
</tbody>
</table>

**Sociodemographic Characteristics**

- **Group**
  - Subject: 36
  - Control: 32
- **Age**
  - 36: 24 (23, 27), 32: 25, 31.9
- **Gender**
  - Female: 20, Male: 16
- **Race**
  - White: 29, 80.6%, 26, 81.3%
  - Black/African American: 0, 0.0%
  - American Indian/Alaska Native: 2, 5.6%
  - Asian: 5, 13.9%
  - Native Hawaiian/Pacific Islander: 0, 0.0%
  - Other: 0, 0.0%
- **Ethnicity**
  - Non-Hispanic/Latino: 27, 75.0%, 25, 78.1%
  - Hispanic/Latino: 9, 25.0%, 7, 21.9%

**Social Characteristics**

- **Living Situation**
  - With Other Medical Students: 5, 13.9%, 5, 15.6%
  - With Other non-Medical Students: 1, 2.8%, 1, 3.1%
  - With Family: 8, 22.2%, 8, 25.0%
  - With Others: 11, 30.6%, 10, 31.3%
  - Alone: 9, 25.0%, 7, 21.9%
  - Other: 2, 5.6%
- **Living with children <18 years old**
  - 36: 2, 5.6%, 32: 2, 6.3%
- **Living with pets**
  - Dog: 10, 27.8%, 9, 28.1%
  - Cat: 7, 19.4%, 4, 12.5%
- **Frequent Contact with Livestock**
  - 36: 0, 0.0%, 32: 0, 0.0%
  - 36: 0, 0.0%, 32: 0, 0.0%
  - 36: 0, 0.0%, 32: 0, 0.0%
- **Daily Tobacco Use**
  - 36: 0, 0.0%, 32: 0, 0.0%
  - 36: 0, 0.0%, 32: 0, 0.0%
  - 36: 0, 0.0%, 32: 0, 0.0%
- **Care for a Chronically Ill Person at Home**
  - Currently Employed: 36, 5, 13.9%
  - Prior Healthcare Experience: 36, 30, 85.3%
  - Prior Approx. Healthcare Exposure Hours: 19, 2,220 (300, 5070)

**Medical History**

- **Underlying Medical Conditions**
  - 35: 3, 8.3%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 7, 19.4%
  - 36: 32, 88.9%
  - 35: 2, 5.6%
  - 35: 2, 5.6%
  - 35: 1, 2.8%
  - 35: 1, 2.8%
  - 36: 14, 38.9%
  - 36: 14, 38.9%
- **On a Current Steroid Regimen**
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
- **Steroid Administration Within the Past 3 mos**
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
- **Antibiotic Administration Within the Past 6 mos**
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
- **Antibiotic Course Completion Rate**
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
- **Hospitalization Within the Past 6 mos**
  - 35: 2, 5.6%
  - 35: 2, 5.6%
  - 35: 2, 5.6%
  - 35: 2, 5.6%
  - 35: 2, 5.6%
  - 35: 2, 5.6%
  - 35: 2, 5.6%
- **Surgery Within the Past 6 mos**
  - 35: 2, 5.6%
  - 35: 2, 5.6%
  - 35: 2, 5.6%
  - 35: 2, 5.6%
  - 35: 2, 5.6%
  - 35: 2, 5.6%
  - 35: 2, 5.6%
- **Ever Had a Skin Infection**
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
- **Ever Been Diagnosed with a MRSA Infection**
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
- **Ever Had a Respiratory Infection/Pneumonia**
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
- **Currently Ill**
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%
  - 36: 1, 2.8%

**Laboratory Results**

- **Positive Culture**
  - 36: 12, 33.3%
  - 36: 10, 31.3%
  - 36: 12, 100.0%
  - 36: 0, 0.0%
  - 36: 0, 0.0%
  - 36: 12, 100.0%
- **Coagulase Test**
  - Positive: 32, 10, 100.0%
  - Negative: 32, 10, 100.0%
  - 36: 10, 100.0%
  - 36: 10, 100.0%
  - 36: 10, 100.0%
- **PCR**
  - Positive: 32, 10, 100.0%
  - Negative: 32, 10, 100.0%
  - 36: 10, 100.0%
  - 36: 10, 100.0%
6.1 Descriptive Statistics

6.1.1 Sociodemographic Characteristics

The variables were derived from questions included in the participant survey administered by BCOM researchers. The sample consisted of 36 participants (n=36), men (n=16) and women (n=20). 32 of those participants were subjects (88.9%) and 4 participants were controls (11.1%). The median age for both subjects and controls was 24 years (IQR: 23, 27).

The majority of participants identified as being White (80.6%), five participants identified as being Asian (13.9%), and two participants identified as being American Indian/Alaska Native (5.6%). The Ethnicity variable consists of two levels, Non-Hispanic/Latino (75%) and Hispanic/Latino (25%).

6.1.2 Social Characteristics

For living situation, participants reported living with other medical students (19.9%), with other non-medical students (2.8%), with family (22.2%), with others (30.6%), alone (25%), and other (5.6%). Two participants reported living with children under 18 years old (5.6%). Participants reported having a dog (27.8%) or a cat at home (19.4%).

No participants reported having frequent contact with livestock. One participant reported the daily use of tobacco (2.8%). No participants reported caring for a chronically ill person at home. Five participants reported being currently employed (13.9%). Most participants reported having prior healthcare experience (83.3%). The median amount of healthcare exposure hours for students who reported having prior healthcare experience was 2.220 hours (IQR: 300, 5070), 11 participants did not provide an approximate amount of prior healthcare exposure hours.
6.1.3 Medical History

Few participants reported having an underlying medical condition (8.3%). One participant reported being on a current steroid regimen (2.8%), and one participant reported having taken steroids within the past three weeks (2.8%). Seven participants reported having taken antibiotics within the past six months (19.4%) and the majority of participants reported always completing the antibiotic course when prescribed (88.9%). Two participants reported being hospitalized within the past six months (5.6%), and one participant reported having had surgery within the past six months (2.8%). Fourteen participants reported ever having a previous skin infection and a respiratory infection (38.9%). Only one participant reported ever being diagnosed with a MRSA infection (2.8%). One participant reported being currently ill at the time of the survey administration (2.8%).

6.1.4 Laboratory Results

Of the 36 nasal swab samples received, 12 (33.3%) samples resulted in having positive cultures for *S. aureus*. Of those twelve positive culture samples, all 12 (100%) samples resulted in being coagulase positive confirming the presence of *S. aureus*. Of the 12 positive *S. aureus* samples, none of the isolates resulted in having the meca gene (0%) therefore, none of the samples were positive for MRSA. Images of samples resulting in positive culture results, with partial and full mannitol fermentation, can be seen in Figure 6.1 and Figure 6.2. PCR results can be seen in Figure 6.3.
Figure 6.1: A culture plate from participant 2880, after 48 hours of incubation, resulting in partial mannitol fermentation.

Figure 6.2: A culture plate from participant 2137, after 48 hours of incubation at 35°C, resulting in full mannitol fermentation.

6.2 Participant Group Differences

The mean age for both the subject participants and control participants were very similar, 25 and 25.5 respectively. There was a small difference between genders in the subject group with 17 subjects being female (53.1%), and 15 subjects being male (46.9%). The majority of control participants were Female (75%), and one participant was male (25%). The race variable was similar between subjects and controls. Most participants identified as being White, subject (81.3%), control (75%). Subjects also identified as being American Indian/Alaska Native (6.3%), and Asian (12.5%). In addition to White, controls also identified as being Asian (25%). The majority of Subjects identified as being Non-Hispanic/Latino (78.1%) rather than Hispanic/Latino (21.9%). Half of the controls identified as Hispanic/Latino (50%).

When asked about their living situation, most subjects responded in living with others (31.3%), living with family (25%), living alone (21.9%), living with other medical students (15.6%), and living with other non-medical students or other (3.1%). Controls responded in living along (50%), living with others (25%), and other (25%). Two participants responded in living with children under 18 years of age (6.3%), while none of the controls responded in living with children under 18 years of age (0%). Subjects and controls reported having a dog at home (28.1% and 25%), and a cat at home (12.5% and 75%). One control participant reported the daily use of tobacco (25%), while no subjects reported the daily use of tobacco (0%). Participants responded in whether they are currently employed, subjects (3.1%) controls (100%). The majority of subjects reported having prior healthcare experience (90.6%), while one control reported having prior healthcare experience (25%). The median amount of prior healthcare exposure hours for subjects was 2,220 (IQR: 300, 5,070). The control participant who responded in having prior healthcare experience did not provide an approximate amount of healthcare exposure hours.
Subjects reported having underlying medical conditions (9.4%), while no controls reported having underlying medical conditions. One participant reported being on a current steroid regimen and having taken steroids within the past three weeks (3.1%), as opposed to zero controls (0%). Both subjects and controls reported having taken antibiotics within the past six months (18.8% vs 25%). 90.6% of subjects reported always completing the antibiotic course when prescribed antibiotics, compared to 75% of controls. Two subjects reported being hospitalized within the past six months (6.3%), and having surgery within the past six months (3.1%), compared to no controls. Both subjects and controls reported ever having a skin infection (37.5% vs 50%), and only subjects reported ever being diagnosed with a MRSA infection (3.1%). Subjects and controls reported ever being diagnosed with a respiratory infection or pneumonia (40.6% vs 25%). One subject was currently ill during the time of the survey administration (3.1%).

31.3% of subjects’ nasal samples resulted in a positive culture. 100% of those positive samples were confirmed to be *S. aureus*, however, none of them resulted in being positive for MRSA. 50% of the control nasal swabs resulted in a positive culture. 100% of control-positive cultures were coagulase positive and therefore confirmed to be *S. aureus*. None of the control-positive samples were MRSA.
Chapter 7: Discussion

7.1 Conclusions

A study conducted at a Louisiana medical university studied whether direct hospital exposure in medical and graduate students versus pre-clinical medical students and graduate students with no hospital exposure affected the nasal carriage rate of *S. aureus*. Students with clinical exposure had a *S. aureus* colonization percentage of 25.1% and non-clinical students had a colonization percentage of 7.14% (Wheeler & Morici, 2013). The nasal carriage percentage in this thesis study compared to the Louisiana study is much higher in pre-clinical medical students and slightly higher than students with clinical exposure. Similar to this study, none of the samples were positive for MRSA.

Treesirichod, Hantagool, and Prommalikit (2013) studied nasal carriage of *S. aureus* in pre-clinical medical students attending a medical school in Ongkharak, Thailand. 29.7% of the participants were positive for nasal colonization of *S. aureus*, and out of 128 participants, none were positive for MRSA nasal colonization (Trewesirichod, Hantagool, & Prommalikit, 2013). The authors studied a similar group for *S. aureus* nasal colonization and although the percentage is closer to that of this study, this study revealed a higher percentage of nasal colonization.

Zakai (2015) investigated Methicillin-susceptible *S. aureus* (MSSA) and MRSA colonization in both medical students with clinical exposure and medical students with no clinical exposure in Jeddah, Saudi Arabia (Zakai, 2015). The study revealed 100% of pre-clinical students were colonized with MSSA, but none were positive for MRSA. Of students with clinical exposure, 18.7% were carriers of MSSA and 6.7% were carriers of MRSA. Although susceptible *S. aureus* carriage was higher among pre-clinical medical students, higher MRSA prevalence was found among students with clinical exposure (Zakai, 2015). This study resulted in a much higher *S.
*aureus* prevalence among pre-clinical medical students in comparison with our study, however MRSA carriage results are similar to ours.

Previous studies on colonization percentages in medical students in their pre-clinical years resulted in similar findings as this thesis study. Although all three studies found varying prevalence of colonization, the studies demonstrated a trend of increasing *S. aureus* and MRSA prevalence among students with clinical exposure in comparison to students in their pre-clinical years. Very few pre-clinical students were MRSA positive. Although this thesis study focused on the prevalence of colonization among first-year osteopathic medical students, the parent study aims to continue collecting data on colonization rates as the same group of students as they transition from their pre-clinical years to their clinical years in medical school. The studies discussed above found differences in colonization percentages between pre-clinical and clinical students, however, none of the studies were cohort studies, following the same group of individuals through their transition.

This thesis study found the prevalence of *S. aureus* nasal colonization among first-year, pre-clinical medical students to be 31.3%, and 33.3% overall. The results are similar to the CDC estimate of nasal colonization among healthy adults of 33% (CDC, 2017). The absence of MRSA in a sample of 36 participants is similar to the CDC estimate of 2%, therefore I reject my hypothesis.

### 7.2 Methodological Strengths and Limitations

#### 7.2.1 Strengths

One of the methodological strengths of this thesis study is the administration of the participant survey which consisted of questions addressing risk factors for colonization according to previous literature. The participant survey gave insight to sociodemographic characteristics,
social circumstances, and medical history which are beneficial in the data analysis. Another methodological strength was the immediate plating of samples the same day of collection. In addition, when the coagulase test was performed, the tubes were checked after four hours to account for potential clot autolysis. The coagulase samples were checked again after 18 hours of incubation.

7.2.2 Limitations

One of the methodological limitations of this study was the recruitment process of the controls, resulting in only four controls being recruited. With a small control group that is not similar to the subject group, analyses and comparisons were unable to be made in comparing the two groups. Another methodological limitation to this study was the administration method of the participant survey. When the participant survey was administered to the participants, it allowed for participants to fill-in answers which led to multiple inconsistencies and missing information in their responses. The questions that addressed participant ethnicity and prior amount of healthcare exposure hours were not structured in a form that makes analysis reliable. The responses for Ethnicity included several different responses, often times including nationality and not necessarily ethnicity. Many responses for Prior Healthcare Experience Hours were not approximations of the total amount of experience hours, but employment history and duration of employment instead, and the approximate amount of healthcare exposure hours had to be calculated.
7.3 Analytical Strengths and Limitations

7.3.1 Strengths

The analytical strength of this thesis study is, in addition to gathering data on the prevalence of *S. aureus* colonization, data was also gathered on risk factors and social characteristics to be analyzed, which contributes to the understanding of *S. aureus* nasal colonization among first-year osteopathic medical students.

7.3.2 Limitations

The analytical limitations of this thesis study is that the sample size was fairly small and not representative of the study population. In addition, as a result of the variety of responses received from the ethnicity question, the race and ethnicity the participant was considered may not have been a true representation of that participant. For example, many students stated their ethnicity as being White or Caucasian, and although their race was considered to be White, their ethnicity was considered to be Non-Hispanic/Latino because it was not explicitly stated. However, many of the participants identifying as White or Caucasian may in fact be of Hispanic ethnicity. As discussed in the methodological limitations section, many participants stated their employment history and duration instead of approximating their amount of prior healthcare exposure hours and the approximation calculated may not be accurate. In addition, many participants stated their employment history with no way of approximating hours. For example, a participant may have stated they have experience working as an EMT for two years but did not give an amount of hours per week and was therefore considered as missing data.
7.4 Recommendations

Both the methodological and analytical strength and limitations in this thesis can guide future studies when designing and developing a similar study.

Future recommendations for the laboratory analysis of the nasal samples include possibly conducting disc diffusion assays to explore the susceptibility pattern of the *S. aureus* isolates. In doing so, the degree of resistance present can be observed better and MRSA can be identified by both PCR and cefoxitin resistance.

In addition, modifying the structure of the questions in the participant survey can be beneficial when analyzing the data. The Ethnicity question can be separated into two separate questions, Race and Ethnicity, according to the U.S. Census Bureau with answer choices within the question. Doing so minimizes the amount of inconsistencies in the responses and the responses are a more reliable representation of the sample. When asking participants about their prior healthcare experiences, answer choices can be given with exposure hour ranges as responses. Administering the survey online as an online exam can be beneficial by not allowing participants to proceed if a question has not been answered. A few participants stated they had prior healthcare experience, however when asked to approximate those hours and describe the experiences, the question was left blank. By not allowing participants to skip questions, variables have fewer missing values.

Lastly, prior to obtaining nasal samples from medical students, researchers can make sure they have recruited enough control participants to provide samples as well in order to ensure comparable sample sizes.
Chapter 8: Strategic Frameworks

This thesis study is relevant to three strategic frameworks: Healthy People 2020, the City of El Paso’s Community Health Assessment and Improvement Plan (CHA/CHIP), and the CDC’s Framework for Preventing Infectious Diseases. Although a topic area of the Healthy Border 2020 strategic framework pertains to infectious diseases, none of the objectives listed related to reducing nosocomial *S. aureus*/MRSA infections or surveillance of *S. aureus*/MRSA infections. None of the priority areas listed in the Paso Del Norte Regional Strategic Health Framework pertained to infectious disease surveillance or healthcare-associated infection transmission.

8.1 Healthy People 2020

Healthy People 2020 is a national strategic framework that provides science-based 10-year objectives to improve the health of U.S. Citizens (U.S. Department of Health and Human Services, 2014; U.S.-Mexico Border Health Commission (BHC), ). The U.S. Department of Health and Human Services releases a set of goals and objectives each decade to promote health measure progress for health-related illnesses prevalent in specific populations.

The Healthy People 2020 topic area relevant to this thesis study is Healthcare-Associated Infections, specifically the HAI-2 objective to “reduce invasive healthcare-associated methicillin-resistant *Staphylococcus aureus* (MRSA) infections (U.S. Department of Health and Human Services, 2014). The objective aims to reduce HA-MRSA infections from the baseline of 27.08 infections per 100,000 persons to 6.56 infections per 100,000 persons. HA-MRSA infections have decreased thus far to 17.30 infections per 100,000 persons in 2014 (U.S. Department of Health and Human Services, 2014). This thesis studied prevalence of *S. aureus* and MRSA colonization in medical students who can potentially serve as vectors in transmitting the pathogen to patients. Increasing awareness of colonization rates among students transitioning from medical school to
the clinical setting may aid in reducing nosocomial MRSA infection in patients through screening and decolonization methods.

8.2 City of El Paso Community Health Assessment

The City of El Paso Department of Public Health (DPH), in collaboration with the Community Advisory Board (CAB), developed the Community Health Assessment and Improvement Plan (CHA/CHIP) that outlines the health issues facing El Paso County residents and aims to improve the health of the community (City of El Paso Department of Public Health, 2013). The Community Health Assessment contains a needs assessment of the health issues prevalent to El Paso County and aims to influence community stakeholders to take action in promoting health and reducing disease.

The priority area in the CHA/CHIP relevant to this thesis study is “Priority Area 6: Surveillance and Communicable Disease Prevention” (City of El Paso Department of Public Health, 2013). Objective 6.2 “target surveillance and communicable disease prevention and interventions to geographic areas of highest need including colonias, select ZIP codes El Paso” is closely related to this thesis study. The CHA/CHIP does not contain an objective specific to S. aureus/MRSA, or reducing the transmission of infectious diseases in the healthcare setting.

8.3 CDC Framework for Preventing Infectious Diseases

The CDC’s Infectious Disease Framework was developed by multiple CDC organization units including CDC’s Office of Infectious Diseases, Influenza Coordination Unit (ICU), and infectious disease national centers (Centers for Disease Control and Prevention, 2011). The framework aims to improve the CDC’s ability to prevent infectious diseases and stay up-to-date
with rare, dangerous, and emerging infectious disease threats. The framework outlines three
elements that consist of strong public health fundamentals, high-impact interventions, and sound
health policies. Each element contains a set of priorities and activities to achieve each element.

The element relevant to this thesis study is “Element 1: Strengthen public health
fundamentals, including infectious disease surveillance, laboratory detection, and epidemiologic
investigation” (Centers for Disease Control and Prevention, 2011). The specific priority relevant
to this thesis is “Priority 1A: Modernize infectious disease surveillance to drive public health
action” (Centers for Disease Control and Prevention, 2011). Under Priority 1A, the CDC states
they are working with public health partners and the healthcare community to improve surveillance
of infectious diseases from the local level, to the federal level (Centers for Disease Control and
Prevention, 2011). Element 1 and Priority 1A closely relate to this thesis as this study was
conducted to gather data on colonization prevalence in future medical professionals.
Chapter 9: MPH Core Competencies

The MPH program at UTEP has adapted, from the Association of Schools of Public Health (ASPH), and developed specific core competencies that guide all courses, training, research, and the practicum in the MPH program (University of Texas at El Paso College of Health Sciences Department of Public Health Sciences, 2017). The core competencies adapted from the ASPHA consist of: Biostatistics, Environmental Health Sciences, Epidemiology, Health Policy and Management, and Social and Behavioral Sciences. The core competency developed specifically for the MPH program at UTEP is the Hispanic and Border Health Concentration competency (University of Texas at El Paso College of Health Sciences Department of Public Health Sciences, 2017). The core competencies relevant to this thesis study are Biostatistics, Epidemiology, and Hispanic and Border Health Concentration.

9.1 Biostatistics

The Biostatistics core competency consists of “the development and application of statistical reasoning and methods in addressing, analyzing, and solving problems in public health; health care; and biomedical, clinical and population-based research” (University of Texas at El Paso College of Health Sciences Department of Public Health Sciences, 2017). This thesis study included the analysis of gathered data including medical history data.

9.2 Epidemiology

The Epidemiology core competency consist of studying disease and injury patterns in communities and using the data to improve health problems (University of Texas at El Paso College of Health Sciences Department of Public Health Sciences, 2017). This thesis study
collected information and human specimens regarding a pathogen capable of causing life-threatening illness. Over the course of the parent, four-year cohort study, the pattern of nasal colonization of *S. aureus* or MRSA in healthcare professionals could provide insight as to the risk it poses to infecting patients.

**9.3 Hispanic and Border Health Concentration**

The Hispanic and Border Health Concentration competency consists of “identifying the major chronic, infectious, and other public health challenges that face Hispanic and border communities” and “applying basic principles of prevention and control for chronic, infectious, and other conditions especially those that differentially impact Hispanic and border communities” (University of Texas at El Paso College of Health Sciences Department of Public Health Sciences, 2017). This thesis study was conducted to gather data useful to potentially decrease and prevent pathogen transmission and reduce the amount of healthcare professionals that may serve as reservoirs and vectors in the transmission of nosocomial infections.
References


PACOSM. (2017). Table 1 differences between CA-MRSA and HA-MRSA. Retrieved from http://www.pacosm.com/specialtopics/infdisease/AAOS%20Now%20May%202008%20p.%20202%20Table%201.pdf


51


Appendix 1

Appendix 1: BCOM IRB Approval Letter

TO: Debra Bramblett, PhD
    Associate Professor and Chair of Bio-Medical Sciences

Michael Woods, PhD
Assistant Professor of Pathology

FROM: Joseph N. Benoit, Ph.D.
Chairperson, BCOM Institutional Review Board

Cc: Stephanie Ayala, BCOM Class of 2020

DATE: July 18, 2017

RE: BCOM IRB# 0012_2017, Rate of MRSA Acquisition in Medical Students From Pre-Clinical to Clinical Years

The Institutional Review Board (IRB) has reviewed your proposal #BCOM IRB 0012_2017 entitled “Rate of MRSA Acquisition in Medical Students From Pre-Clinical to Clinical Years”. I am pleased to inform you that your project proposal has been granted “Full Approval” for implementation at the Burrell College of Osteopathic Medicine, Las Cruces, NM. Receipt of this notice grants you permission to begin the data collection and research described in your proposal.

Please note that as Principal Investigator, you are responsible for promptly reporting any changes to the study protocol and also reporting any injuries, adverse events, or unanticipated events that effect research subjects to the IRB Chairperson at the following email addresses: jbenoit@bcomnm.org or research@bcomnm.org or by phone (575) 574-2321.

Federal Guidelines dictate that IRB-approved research must be reviewed no less than once a year. Your Continuation Review/Progress Report will be due on July 17, 2018. Please contact the Office of Research & Sponsored Programs for necessary forms. Please be aware that the BCOM IRB will be conducting routine audits of active protocols as a means of ensuring compliance with federal policies and protection of human subjects in research. Your project may be audited at any time as part of these procedures.

The IRB thanks you for your cooperation and wishes you well on the conduct of your research. Please direct any questions or concerns directly to me or our IRB Administrative Coordinator, Ms. Martha Cardoza.
Appendix 2

Appendix 2: UTEP Rely-On IRB Agreement


Name of Institution or Organization Providing IRB Review (Institution A):
Name: Burrell College of Osteopathic Medicine
Address: 3501 Arrowhead Drive, Las Cruces, NM 88001
IRB Registration #: 00010422
Assurance (FWA) #: 00024071

Name of Institution or Organization Relying on the Designated IRB (Institution B):
Name: The University of Texas at El Paso
Address: 500 W. University Avenue, El Paso, TX 79968
Assurance (FWA) #: 00001224

The Officials signing below agree that Institution B may rely on the designated IRB at Institution A for review and continuing oversight of its human subject research described below: (check one)

( ) This agreement applies to all human subject research covered by Institution B’s FWA.

( X ) This agreement is limited to the following specific protocol(s):

- **Study Title:** Rate of MRSA Acquisition in Medical Students From Pre-Clinical to Clinical Years
- **Institution A Investigator/Study #:** Debra Bramblett, IRB0012_2017
- **Institution B Investigator:** Delfina C. Dominguez, MT (ASCP), MS, PhD
- **Sponsor:** Burrell College of Osteopathic Medicine, 3501 Arrowhead Drive, Las Cruces, NM 88001

( ) Other (describe):

The review performed by the designated IRB will meet the human subjects protection requirements of Institution B’s OHRP-approved FWA. The IRB at Institution A will follow written procedures for reporting its findings and actions to appropriate officials at Institution B. Relevant minutes of IRB meetings will be made available to Institution B upon request. Institution B remains responsible for ensuring compliance with the IRB’s determinations and with the terms of its OHRP-approved Assurance. This document must be kept on file at both institutions and provided to OHRP upon request.

Signature of Signatory Official (Institution A): ____________ Date: 8/2/2017

Full Name: Robert J. Ketchum, Ph.D., Institutional Title: Senior Associate Dean for Academic Affairs & Preclinical Education/Institutional Official

NOTE: The IRB of Institution A must be designated on the OHRP-Approved FWA for Institution B.

Signature of Signatory Official (Institution B): ____________ Date: ____________

Full Name: Roberto A. Oseguera, Ph.D., Institutional Title: Vice President for Research/Institutional Official
Appendix 3

Appendix 3: Research subject background information and consent form

Burrell College of Osteopathic Medicine
MEDICAL STUDENTS & MRSA A LONGITUDINAL STUDY

PRINCIPAL INVESTIGATORS:
Dr. Debra Bramblett & Dr. Michael Woods

INFORMED CONSENT
APRIL 2017

RESEARCH SUBJECT BACKGROUND INFORMATION AND CONSENT FORM

Purpose: You are being asked to participate in a research study that involves completion of a survey and collection of swab from inside of your nose. This consent form will educate you on the background of the study, the procedures involved if you decide to enroll, and the risks and benefits. You will be provided with contact information to the study investigators as well so that you may ask questions in the future. Before enrolling in this study please be sure that you ask any questions you may have. Questions can be directed to the investigators of the study.

What is this Study About?
We are following first year medical students over their 4 years of education to determine if they become colonized with a type of bacteria in their nostrils. The bacteria is called methicillin resistant Staphylococcus aureus. We are interested in this particular bacterium because it can be a source of serious infection but is often “carried” in the nostrils of people who have no symptoms. This can be a problem, especially for healthcare workers, because the bacteria can be spread unknowingly, to a patient, healthcare staff, or anyone else in close contact. We feel that measuring this occurrence will help to prevent spread and acquisition of this bacteria by future medical students.

Who is conducting this study?
The principal investigators for this study are Dr. Debra Bramblett and Dr. Michael Woods. The student investigators are Stephanie Ayala OMS II, Marlina Ponce de Leon OMS II, Chris Hooshmand OMS II, and Andrew Ortega OMS II.

Why am I being asked to participate in this study?
Since you are a first year medical student, we are requesting your participation in this study.

What can I expect if I participate in this research study?
If you decide to participate in this study, we ask that you first read through this consent thoroughly, have an understanding of the procedure, and ask any questions you may have. After the consent is complete, we will ask you to complete a brief survey that collects information about yourself and your medical history. Following the survey, a swab will be inserted into your nostril to collect the specimen. The swab will then be processed and results recorded by the investigators. You will be assigned a randomized number and the principal investigators will store your information from the survey and swab results under lock and key. The student investigators will not know the randomized numbers assigned to subjects/students. This process (survey and nasal swabs) will be repeated at the end of your first year of school, and at the beginning and end of your second, third, and fourth years. You will not incur any cost as a result of this study. You will only be notified of a result if you are positive for MRSA. In that case, one of the principal investigators will contact you to relay this information and to discuss options for seeking treatment.
What if I test positive for MRSA?
If you test positive, you will meet with either or both of the principal investigators. Information will be provided to you on how you can seek treatment. The Burrell College of Osteopathic Medicine will not provide treatment for you, nor will they compensate you for treatment and/or doctors visits associated with this study. Neither positive nor negative results will be disclosed to anyone else other than the principal investigators and the subject involved. It is important to note that if you do test positive throughout this study, you must follow any requirements that your clinical rotation sites may have in regards to individuals who test positive for MRSA. If you decline treatment, you may be required to wear a mask throughout the duration of your clinical rotations.

Are there any risks involved?
There may be some discomfort when the nasal swab is inserted in your nose. This may also cause bleeding from the nose, however, this is unlikely.

Are there any benefits of participating in this study?
There are no direct benefits to you. You will not be compensated for your involvement in this study. There may be benefits to others in the future because of your participation in this study.

What if I do not want to participate in this study?
If you do not wish to participate you do not need to do anything further. You may simply decline to participate. If you decide to participate in the study, you may change your mind at any time, and withdraw from the study.

What if I am injured by participating in the study?
There is a very low risk that you will incur personal injury by participating in this study. If this does occur, we will provide information on how you can seek medical care. We will not compensate you for any medical costs you may incur because of your participation in this study.

Will my personal information be shared with anyone else?
Upon collection of the surveys, a randomized number will be assigned and demographic information will be removed. Variables will be collected and the forms will be locked and stored with the principal investigators. The investigators will not share this information with anyone else. At the end of the study, the information will be destroyed from any electronic and/or paper source.

What if I do not want to share my demographic or past history?
By signing this consent form, you grant us permission to use your information in the study. You will not be identified by name or otherwise in terms of any past history information or information provided on the survey.

Can I be removed from the study?
If the study ends, or the principal investigators feel there is a health or safety risk involved with your participation, they have the ability to remove you from the study.

Who Do I contact if I have questions or issues with the study?
Please contact Dr. Debra Bramblett or Dr. Michael Woods if you have any questions or concerns with the study. Their numbers are:

Dr. Debra Bramblett, Associate Professor & Chair, Department of Biomedical Sciences:
Consent - Signatures

Subject Name (Please print)

______________________________________________

Signature of Subject (18 years and older)          Date: ____________

Time: ____________

Date: ____________

Time: ____________

Signature of Person Conducting Informed Consent Discussion

Date: ____________

Time: ____________
Appendix 4: Participant Survey

Burrell College of Osteopathic Medicine
MEDICAL STUDENTS & MRSA A LONGITUDINAL STUDY

SUBJECT SURVEY
APRIL 2017

PRINCIPAL INVESTIGATORS:
Dr. Debra Bramblett & Dr. Michael Woods

Please provide the following answers to the best of your knowledge. If you leave any answers blank, please fill that area in as "N/A".

We appreciate your time and effort.

Demographics
Name_________________________ Age__________

Please circle one: OMS I  OMS II  OMSIII  OMS IV
Gender: M  F

Ethnicity: African American __ Hispanic __ Caucasian __ Asian__ Indian __ Native American __
Other: (please specify)________________________

Social Data:
Do you currently live alone?  Y  N

If you answered no to the previous question, please choose one option to describe your living situation
• Live in a dorm with other medical students
• Live in a dorm with non-medical students
• Live with family
• Live with others
• Homeless
• Other________________________

Are there children in your household (less than 18 years of age)?  Y  N

Do you have a dog or cat at home?  Y  N

If yes, please choose an option:  DOG  CAT  BOTH

Do you have frequent (once a week or more) contact with livestock such as cows, pigs, sheep, chickens?  Y  N

Do you smoke tobacco daily?  Y  N

If no, but you do use tobacco, please indicate how much and how often _______________________

Do you care for a chronically ill person at home?  Y  N

Are you currently employed?  Y  N

If yes, please list your occupation
Do you have prior healthcare experience? Y N
If yes, please list those experiences here.

Hours of healthcare experience (approximate if needed):

Medical History:
Do you have any health problems? Y N
If yes, please list them here.

Are you on chronic steroids?
Have you taken any steroids within the past 3 weeks?
Have you been on antibiotics in the past 6 months? Y N
If yes, please list the name(s) of those antibiotics:

When you take antibiotics, do you always finish the entire course? Y N Sometimes

Have you been hospitalized in the past six months? Y N
Have you had surgery in the past 6 months? Y N
Have you ever had a skin infection? Y N
Have you ever been diagnosed with a MRSA infection? Y N
Have you ever had a respiratory infection or pneumonia? Y N
Are you currently ill? Y N
If yes, please describe the illness
Vita

Samantha Meza obtained her Bachelor of Science Degree in Biological Sciences with a Biomedical Concentration and with an Honors Degree from the University of Texas at El Paso (UTEP). As an undergraduate student, Samantha worked as a research assistant in Dr. Delfina Dominguez’s laboratory studying the prevalence of efflux pumps and biocide determinants in Methicillin-Resistant *Staphylococcus aureus* (MRSA) as mechanisms of antimicrobial resistance. In addition, she also studied and genetically characterized Extended-Spectrum β-Lactamase (ESBL) producing genes in *Escherichia coli*. Samantha has presented her research findings at the 2015 Spring COURI Symposium at UTEP, the 2016 Texas Association for Clinical Laboratory Science (TACLS) annual conference in San Antonio, Texas, and at the 2017 ASM Rio Grande Branch annual meeting at New Mexico State University.

Samantha began the Master of Public Health (MPH) program at UTEP in the Fall of 2016. She received a travel award from the UTEP graduate school to present a poster at the international conference ASM Microbe 2017 in New Orleans, Louisiana. Samantha published her article titled “A Survey of Biocide Resistant Determinants in *Staphylococcus aureus* Strains Collected from Hospitals in the Southwest U.S.-Mexico Border region” in the September 2017 issue of the El Paso Physician magazine. Samantha began working as a Graduate Intern for the El Paso Department of Public Health in the summer of 2017 for the Emergency Preparedness Program, where she also plans to complete her practicum. Samantha has been accepted to and will attend Burrell College of Osteopathic Medicine in the Fall semester of 2018 and she plans to continue studying infectious diseases prevalent at the U.S.-Mexico border region.

Contact Information: samanthamichelle08@yahoo.com

This thesis/dissertation was typed by Samantha Meza.