Infection Control Practices and Methicillin-Resistant *Staphylococcus aureus* Skin Infections: A Survey of Students in US Chiropractic Programs

Jonathon T. Egan, DC, MPH, PhD

ABSTRACT

Objective: The purpose of this study was to assess the incidence of self-reported history of physician-diagnosed methicillin-resistant *Staphylococcus aureus* (MRSA) skin and soft tissue infection (SSTI) among chiropractic students and any association with infection control behaviors (hand and table hygiene, sharing gowns, and sharing lotion) and initiation of patient care.

Methods: Questionnaires were obtained from 312 students attending half (9/18) of US chiropractic campuses. The questionnaire was derived from earlier studies led by Bearman in 2010 and Evans in 2007. Associations were assessed with Fisher exact test. Crude odds ratios were calculated for each of the variables. Two logistic regression models were produced.

Results: Attendance at 1 campus was associated with postmatriculation MRSA SSTI in univariate analysis ($P = .010$). The logistic regression model was significant ($P < .05$), but the composing variables were not.

Conclusions: Fewer than 5 cases of MRSA SSTI were detected overall, revealing a low rate of reported postmatriculation MRSA SSTI among these students. There was a univariate association with postmatriculation MRSA SSTI at 1 chiropractic college. (J Chiropr Med 2018;17:75-81)

Key Indexing Terms: Methicillin-Resistant *Staphylococcus aureus*; *Staphylococcal Skin Infections*; *Chiropractic*; *Students*; *Hygiene*; *Infection Control*; *Soft Tissue Infections*; *Cross-Sectional Studies*

INTRODUCTION

Methicillin-resistant *Staphylococcus aureus* (MRSA) is the most common cause of cultured skin and soft tissue infection (SSTI) in US emergency rooms^{1,2} and primary care clinics.³ Half (53.9%) of US hospital *S. aureus* isolates are resistant,⁴ and invasive MRSA is one of the most important causes of US infectious disease mortality.⁵⁻⁷ It is not clear if the rate of MRSA infection in the United States is decreasing, despite efforts to address these infections.⁸ Hygiene-related behaviors have been implicated in MRSA transmission.⁹⁻¹⁸ Hygiene guidelines are often followed poorly across health care professions and settings.¹⁹

Risks for MRSA exposure and transmission in medical settings are documented.^{6,7,19-22} Despite parallel MRSA environmental contamination rates in chiropractic²³⁻²⁷ and medical²⁸ settings, there has not been a study of MRSA infection history in chiropractic settings. This lack of study of MRSA infection in chiropractic is remarkable, given the size of the chiropractic profession,²⁹ the treatment and training provided via skin contact^{30,31} in millions of patient visits,^{32,33} and hundreds of hours of skin contact during student training^{31,34}—all in an era of antibiotic-resistant organisms such as MRSA.

Although there have been prior studies of clinical hygiene infection control behaviors among chiropractic students,^{35,36} none has linked these behaviors to a health outcome, and none of the behaviors have been re-assessed in several years. Although there have been prior studies of MRSA nasal carriage in US health care students,³⁷⁻⁴² none that the author is aware of has specifically screened for postmatriculation infection history, though others have generally inquired about past MRSA infection.⁴² This study sought to determine the rates of prematriculation and postmatriculation MRSA SSTI in a sample of chiropractic students and any association with hygiene-related behaviors and initiation of patient care.

Los Angeles College of Chiropractic, Southern California University of Health Sciences, Whittier, California.

Corresponding author: Jonathon T. Egan, DC, MPH, PhD, Los Angeles College of Chiropractic, Southern California University of Health Sciences, 16200 Amber Valley Drive, Whittier, CA 90604. Tel.: +1 315 694 6375. (e-mail: eganjonathon@gmail.com).

Paper submitted January 10, 2018; in revised form March 20, 2018; accepted March 21, 2018.

1556-3707

© 2018 National University of Health Sciences.

<https://doi.org/10.1016/j.jcm.2018.03.001>

METHODS

All US chiropractic colleges except the author's employer at the time of the study were invited to participate, and 9 agreed. This resulted in an invited pool of about 40% of all US chiropractic students (the exact number of students on each campus or in total will not be revealed to prevent identification of participating campuses, which were promised complete confidentiality). Students were excluded if they were not currently enrolled as a chiropractic student, if they were 17 years of age or younger or 65 years of age or older, or if they attended the author's college. The enrolled sample of respondents included 312 students from all 9 campuses, at which approximately 3945 chiropractic students attended.

Institutional review board ethics approval was obtained from Walden University on July 21, 2016 (Reference No. 07-21-15-0044721). Each participating college campus also individually gave permission for the study to be performed on the campus. The colleges emailed their students the study information and informed consent form for review. At least 48 hours later, the colleges distributed the first of 3 rounds of surveys; 2 subsequent survey emails were sent at least 4 days apart. The Web-based survey was secure and encrypted through Qualtrics (QLite version) (Qualtrics, Provo, Utah). Participation was voluntary. The data sets generated during and analyzed during the current study are confidential and not publicly available because of the sensitivity of the subject. Survey respondents and participating colleges were assured that raw data would remain confidential and would not be shared.

As there was no standard, accepted survey for MRSA risk factors,⁴³ the content for this survey stemmed from previously published sources^{9,36} and the Centers for Disease Control and Prevention's 2013 case report form for Invasive Methicillin-Resistant-*Staphylococcus aureus* Active Bacterial Core Surveillance. Permission was received as needed to use and adapt the questionnaires. An excerpt of the study survey is provided in Supplementary Appendix A (available online). Table 1 reveals the literature-based demographics, infection control variables, and health care history variables assessed in the questionnaire. Data were collected between August and October 2015. Data were analyzed using Stata (Small Stata Version 14.1) (StataCorp, College Station, Texas) and IBM SPSS Statistics Premium (Version 21.0.0.0, IBM Corp, Armonk, New York). Incomplete surveys were not used.

RESULTS

Complete questionnaires were received from 312 unique participants attending 9 US chiropractic college campuses. Respondents represented approximately 8% of all chiropractic students at these campuses (the precise total is obscured to preserve the confidentiality of participating colleges, which otherwise could easily be identified by using the total number of students on the campuses in concert with public Integrated Postsecondary Education

Data System data). Figure 1 illustrates participant flow. Overall, 91.0% of students who entered the Qualtrics portal (QLite version) met inclusion criteria and completed the entire questionnaire.

Participant characteristics are reported in Table 1. Univariate analysis was conducted for all variables with Fisher exact test because of the limited number of cases, all of which were reported by students attending campus 6, and only attendance at campus 6 was significant ($P = .010$, 95% confidence interval = 4.711 to *, with Stata unable to provide the upper confidence interval because of the limited number of cases).

Crude odds ratios were calculated individually in Stata for the association between each of the hygiene variables and MRSA SSTI. Stratum-specific odds ratios and weighted Mantel-Haenszel odds ratios were calculated, but there were too few cases to produce meaningful statistics.

A binary logistic regression model was produced using the 5 infection control and main variables (hand hygiene, table hygiene, sharing gowns, sharing lotions, and initiating patient care) as well as 2 variables significant at $P < .20$ in univariate analysis (campus 6 and history of prior MRSA SSTI). Though the model was statistically significant ($\chi^2(7) = 18.158$, $P = .011$), none of the 7 composing variables was significant.

Last, an additional Fisher exact test for campus 6 and prematriculation MRSA SSTI was evaluated post hoc to determine if the univariate association with campus 6 might simply reflect a disproportionate distribution of students enrolling at that campus with a prior history of MRSA SSTI, which, if true, could lead to a recommendation for pre-enrollment MRSA history screening. However, there was no association between prior MRSA infection and attendance at campus 6 ($P = 1.000$ 2-sided test).

DISCUSSION

This study found that 32.7% of students were infrequent hand sanitizers, and 67% of students were infrequent table sanitizers. A prior study at 3 chiropractic colleges had reported that 22% of students were infrequent hand washers, and 71% infrequently cleaned their tables.³⁵ This suggests that the hand and table sanitation practices of chiropractic students are unimproved since the prior study. This study was conducted prior to the American Chiropractic Association's adoption of the Infection Control for Chiropractic Practice policy, revised in March 2017. This policy replaced a 2010 hygiene policy that was a recommendation. The prior 2010 policy did not appear to affect student hygiene practice, based on the results of this study at 9 campuses as compared with the prior study at 3 colleges published in 2009.³⁵ Poor compliance with mainstream infection control practices by these students does not appear to have been associated with MRSA SSTI, with few cases reported.

Table 1. Study Participant Characteristics (N = 312)

Variable	n (%)
Female	166 (53.2)
Age, y (mean $\pm$ SD)	28.04 $\pm$ 6.33
Race	
White/Caucasian	245 (78.5)
Hispanic or Latino origin	22 (7.1)
Asian	19 (6.1)
Black or African American	11 (3.5)
Other	9 (2.9)
Country of origin (birth): United States	277 (88.8)
US chiropractic college campus ^a	
Campus 1	64 (20.5)
Campus 2	51 (16.3)
Campus 3	50 (16.0)
Campus 4	41 (13.1)
Campus 5	36 (11.5)
Campus 6	32 (10.3)
Campus 7	23 (7.4)
Campus 8	10 (3.2)
Campus 9	5 (1.6)
Military service	12 (3.8)
Jail	20 (6.4)
Injected drugs	8 (2.6)
Postmatriculation MRSA SSTI	# (#)
Health care exposures ^b	
Prematriculation MRSA SSTI	10 (3.2)
Surgery ^b	13 (4.2)
Dialysis ^b	# (#)
Hospitalization ^b	10 (3.2)
Central venous catheter ^b	# (#)
Residence in long-term care ^b	# (#)
Initiation of patient care	89 (28.5)

(continued in next column)

Table 1. (continued)

Variable	n (%)
Share lotion, lubricant, or emollient	56 (17.9)
Share patient gowns	36 (11.5)
Infrequent hand hygiene ^c	102 (32.7)
Infrequent table hygiene ^c	209 (67.0)

MRSA, methicillin-resistant *Staphylococcus aureus*; SD, standard deviation; SSTI, skin and soft tissue infection.

Variables with fewer than 5 cases are reported as "# (#)."

^a The 9 chiropractic campuses listed here are listed in order of the number of student responses received from each campus. The order does not represent any characteristic that might be used to identify any individual US chiropractic campus. The response rates varied at the campuses, and no effort should be made to correlate the campuses listed here with any specific chiropractic college campus.

^b A combination of any exposures reported by the students, whether before prematriculation MRSA SSTI, before postmatriculation MRSA SSTI, or occurring in the past 12 months before answering the survey.

^c "Infrequent" combines the "never," "rarely," and "occasionally" responses in the questionnaire.

The present study did not find that initiating patient care during chiropractic education was associated with diagnosed MRSA SSTI. Other studies have looked at stage of clinical education or years of internship in other fields of health care relative to acquisition of MRSA nasal carriage, an outcome related to the present study. These studies had mixed findings.^{38,44-48}

The incidence of MRSA SSTI was lower than expected based on prior literature. The actual incidence was not reported because fewer than 5 cases were found, and per the institutional review board approval for this study, no cell with a value <5 will be reported individually. However, even if there had been 5 cases of MRSA SSTI, the multiyear incidence in chiropractic students would have been 5 cases per 312 students, or only 1.6% of students affected at any point since matriculation. The annualized MRSA SSTI incidence in a variety of populations has ranged from 4.2% and 8.1% in Army recruits in training^{49,50} to 1.8% in a population-based assessment in an integrated health system,⁵¹ to 0.79% in college athletes⁵² and similar rates in seasonal high school athletes,⁵³ to 8% in a 4-hospital health system based on surveillance cultures.⁵⁴ In the present study, despite the presence of potential risk factors in many participants, the overall rate of MRSA SSTI was below 1.6% over the entire postmatriculation period. This was a multiyear incidence and, therefore, lower than any of the annual rates in any of these comparison groups except perhaps the college athletes. This is consistent with literature reporting that education contributes significantly to the ability to predict mortality risk and that inclusion of educational status can significantly improve the predictive ability of comorbidity indices.⁵⁵ A population composed entirely of graduate health students might be expected to experience a variety of health challenges,

Fig 1. Participant flow and response/completion rate through recruitment and survey process at 9 US chiropractic college campuses. Excluded participants (“ineligible”) appear to exceed 26, as participants could select multiple exclusion criteria.

including MRSA SSTI, less frequently than other populations.

Limitations

Although the study included chiropractic college campuses from across the United States, limitations to generalizability remain. This study ultimately applies specifically to the 312 participants and, more generally, to the 9 chiropractic campuses that agreed to participate and from which participants were drawn. However, the representativeness of these 312 students to all the students at these campuses is not clear. Because these campuses do contain approximately 40% of the US chiropractic student body attending half (9/18) of the US chiropractic campuses, there may be some generalizability to the entire US chiropractic student population. The extent of this generalizability is not clear. This study had an approximately 9% initial response rate among all students at these campuses; there is no way to know how results may have varied if there had been additional respondents. It is not known if individuals with or without infection history chose not to participate. It is not known if participating campuses varied in important ways from nonparticipating campuses. The survey did not ask about access to sinks and hand sanitizer in teaching and clinical settings, which may have affected compliance and outcomes and may have been an important difference between participating and nonparticipating campuses.

Construct validity in this study stemmed from basing the questionnaire on pre-existing questionnaires after an exten-

sive literature review. Construct validity matters, but the important weakness is that there is no standard, validated MRSA risk factor survey or questionnaire for this kind of study. Determining these factors remains an important need for future study; this study survey used factors that were supportable at the time of the study. Though this survey was based largely on other published instruments, other MRSA risk factor studies have typically suffered from a lack of validity testing of their questionnaires.⁴³

This study did not directly assess the accuracy of students’ self-report data, raising the potential for a response bias such as social desirability bias. Partially addressing this concern, nearly all students who entered the survey completed it (Fig 1). Web-based surveys may reduce the impact of social desirability bias,⁵⁶ and confidentiality was ensured and maintained.^{43,56-58}

The low response rate and small number of MRSA SSTI cases detected in this study challenge reliability and limit the utility of inferential statistics and the strength of conclusion. Fewer than 5 cases of MRSA were reported in this sample of 312 students. A larger sample would be needed to answer these questions with greater certainty and to provide confidence in the reliability of the results. Other methods, such as medical record review and prospective, active surveillance, could reduce potential misclassification bias and help enhance the reliability of findings. Future studies could incorporate these methods.

This study broke new ground by assessing MRSA SSTI infection history in chiropractic students and assessing the link between infection control risk factors and a health

outcome in these students. Additionally, this study assessed infection control behaviors in students at 9 US chiropractic college campuses and found that these behaviors do not appear to have changed in the years since these were previously examined.

CONCLUSIONS

This study obtained the first correlation of infection control hygiene behaviors (frequency of hand and table hygiene, sharing of lotions/lubricants, and sharing of patient practice gowns) and initiation of patient care with self-reported, physician-diagnosed MRSA SSTI in chiropractic students. None of these variables was associated with postmatriculation MRSA SSTI in this sample of 312 chiropractic students from 9 US chiropractic college campuses. Fewer than 5 cases were reported. In univariate analysis, attendance at campus 6, where all cases were detected, was associated with MRSA SSTI. No variables in the regression model were significant. A larger study would be needed to answer the study questions more conclusively.

This study highlights the opportunity to increase outreach and education regarding good clinical hygiene practice, as reported hygiene behaviors have not materially changed over the last decade. Accrediting bodies could better hold colleges accountable for student clinical hygiene practices in teaching and clinical settings.

Fewer than 5 cases of MRSA SSTI were detected overall, revealing a low rate of reported post-matriculation MRSA SSTI among these students. There was a univariate association with post-matriculation MRSA SSTI at 1 chiropractic college. This study is the only study of which the author is aware to investigate the link between infection control behaviors among chiropractic students and any health outcome (MRSA SSTI in this case) or to inquire generally about MRSA SSTI infection history in chiropractic students.

ACKNOWLEDGMENTS

The author thanks Raymond Panas, PhD, who provided input into this study as he served as the author's PhD dissertation advisor. This research was conducted for the author's dissertation while a PhD student at Walden University. The author also thanks Gonzalo Bearman, MD, MPH, FACP, who led the 2010 study from which much of the questionnaire in this study derived. He provided permission to use and adapt his questionnaire from the study.⁹

FUNDING SOURCES AND CONFLICTS OF INTEREST

No funding sources or conflicts of interest were reported for this study.

CONTRIBUTORSHIP INFORMATION

Concept development (provided idea for the research): J.T.E.

Design (planned the methods to generate the results): J.T.E.

Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): J.T.E.

Data collection/processing (responsible for experiments, patient management, organization, or reporting data): J.T.E.

Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): J.T.E.

Literature search (performed the literature search): J.T.E.

Writing (responsible for writing a substantive part of the manuscript): J.T.E.

Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): J.T.E.

APPENDIX A. SUPPLEMENTARY DATA

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jcm.2018.03.001>.

Practical Applications

- Methicillin-resistant *Staphylococcus aureus* skin and soft tissue infection appears to be infrequent among this population of chiropractic students.
- Chiropractic student hygiene practices are essentially unchanged over the last decade since previously reported across multiple institutions.
- Accrediting bodies should consider what more could be done to influence hygiene behavior in academic settings.

REFERENCES

1. Moran GJ, Krishnadasan A, Gorwitz RJ, et al. Methicillin-resistant *S. aureus* infections among patients in the emergency department. *N Engl J Med*. 2006;355(7):666-674.
2. Talan DA, Krishnadasan A, Gorwitz RJ, et al. Comparison of *Staphylococcus aureus* from skin and soft-tissue infections in US emergency department patients, 2004 and 2008. *Clin Infect Dis*. 2011;53(2):144-149.

3. Parchman ML, Munoz A. Risk factors for methicillin-resistant staphylococcal aureus skin and soft tissue infections presenting in primary care: a South Texas Ambulatory Research Network (STARNet) study. *J Am Board Fam Med*. 2009;22(4):375-379.
4. Mera RM, Suaya JA, Amrine-Madsen H, et al. Increasing role of *Staphylococcus aureus* and community-acquired methicillin-resistant *Staphylococcus aureus* infections in the United States: a 10-year trend of replacement and expansion. *Microb Drug Resist*. 2011;17(2):321-328.
5. DeLeo FR, Otto M, Kreiswirth BN, Chambers HF. Community-associated methicillin-resistant *Staphylococcus aureus*. *Lancet*. 2010;375(9725):1557-1568.
6. Hassoun A, Linden PK, Friedman B. Incidence, prevalence, and management of MRSA bacteremia across patient populations—a review of recent developments in MRSA management and treatment. *Crit Care*. 2017;21(1):211.
7. Klevens RM, Morrison MA, Nadle J, et al. Invasive methicillin-resistant *Staphylococcus aureus* infections in the United States. *JAMA*. 2007;298(15):1763.
8. Kavanagh KT, Abusaleem S, Calderon LE. The incidence of MRSA infections in the United States: is a more comprehensive tracking system needed? *Antimicrob Resist Infect Control*. 2017;6:34.
9. Bearman GML, Rosato AE, Assanasen S, et al. Nasal carriage of inducible dormant and community-associated methicillin-resistant *Staphylococcus aureus* in an ambulatory population of predominantly university students. *Int J Infect Dis*. 2010;14(suppl 3):e18-e24.
10. Begier EM, Frenette K, Barrett NL, et al. A high-morbidity outbreak of methicillin-resistant *Staphylococcus aureus* among players on a college football team, facilitated by cosmetic body shaving and turf burns. *Clin Infect Dis*. 2004;39(10):1446-1453.
11. Elias AF, Chaussee MS, McDowell EJ, Huntington MK. Community-based intervention to manage an outbreak of MRSA skin infections in a county jail. *J Correct Health Care*. 2010;16(3):205-215.
12. Ellis MW, Schlett CD, Millar EV, et al. Hygiene strategies to prevent methicillin-resistant *Staphylococcus aureus* skin and soft tissue infections: a cluster-randomized controlled trial among high-risk military trainees. *Clin Infect Dis*. 2014;58(11):1540-1548.
13. Hall AJ, Bixler D, Haddy LE. Multiclonal outbreak of methicillin-resistant *Staphylococcus aureus* infections on a collegiate football team. *Epidemiol Infect*. 2009;137(1):85.
14. Maree CL, Eells SJ, Tan J, et al. Risk factors for infection and colonization with community-associated methicillin-resistant *Staphylococcus aureus* in the Los Angeles County jail: a case-control study. *Clin Infect Dis*. 2010;51(11):1248-1257.
15. Miller LG, Perdreau-Remington F, Bayer AS, et al. Clinical and epidemiologic characteristics cannot distinguish community-associated methicillin-resistant *Staphylococcus aureus* infection from methicillin-susceptible *S. aureus* infection: a prospective investigation. *Clin Infect Dis*. 2007;44(4):471-482.
16. Nerby JM, Gorwitz R, Leshner L, et al. Risk factors for household transmission of community-associated methicillin-resistant *Staphylococcus aureus*. *Pediatr Infect Dis J*. 2011;30(11):927-932.
17. Romano R, Lu D, Holtom P. Outbreak of community-acquired methicillin-resistant *Staphylococcus aureus* skin infections among a collegiate football team. *J Athl Train*. 2006;41(2):141.
18. Barnes SL, Morgan DJ, Harris AD, Carling PC, Thom KA. Preventing the transmission of multidrug-resistant organisms: modeling the relative importance of hand hygiene and environmental cleaning interventions. *Infect Control Hosp Epidemiol*. 2014;35(9):1156-1162.
19. Calfee DP, Salgado CD, Classen D, et al. Strategies to prevent transmission of methicillin-resistant *Staphylococcus aureus* in acute care hospitals. *Infect Control Hosp Epidemiol*. 2008;29(suppl 1):S62-S80.
20. Klevens RM, Morrison MA, Fridkin SK, et al. Community-associated methicillin-resistant *Staphylococcus aureus* and healthcare risk factors. *Emerg Infect Dis*. 2006;12(12):1991-1993.
21. McDougal LK, Fosheim GE, Nicholson A, et al. Emergence of resistance among USA300 methicillin-resistant *Staphylococcus aureus* isolates causing invasive disease in the United States. *Antimicrob Agents Chemother*. 2010;54(9):3804-3811.
22. Naimi TS, LeDell KH, Como-Sabetti K, et al. Comparison of community- and health care-associated methicillin-resistant *Staphylococcus aureus* infection. *JAMA*. 2003;290(22):2976.
23. Bifero A, Prakash J, Bergin J. The role of chiropractic adjusting tables as reservoirs for microbial diseases. *Am J Infect Control*. 2006;34(3):155-157.
24. Burnham K, Peterson D, Vavrek D, Haas M. The impact of microbial surveys on disinfection protocols in a chiropractic college environment. *J Manipulative Physiol Ther*. 2009;32(6):463-468.
25. Evans Jr MW, Breshears J, Campbell A, Husbands C, Rupert R. Assessment and risk reduction of infectious pathogens on chiropractic treatment tables. *Chiropr Osteopat*. 2007;15:8.
26. Evans Jr MW, Campbell A, Husbands C, Breshears J, Ndetan H, Rupert R. Cloth-covered chiropractic treatment tables as a source of allergens and pathogenic microbes. *J Chiropr Med*. 2008;7(1):34-38.
27. Puhl AA, Reinhart CJ, Puhl NJ, Selinger LB, Injeyan HS. An investigation of bacterial contamination on treatment table surfaces of chiropractors in private practice and attitudes and practices concerning table disinfection. *Am J Infect Control*. 2011;39(1):56-63.
28. Ohl M, Schweizer M, Graham M, Heilmann K, Boyken L, Diekema D. Hospital privacy curtains are frequently and rapidly contaminated with potentially pathogenic bacteria. *Am J Infect Control*. 2012;40(10):904-906.
29. Meeker WC, Haldeman S. Chiropractic: a profession at the crossroads of mainstream and alternative medicine. *Ann Intern Med*. 2002;136(3):216.
30. Evans Jr MW, Ramcharan M, Floyd R, et al. A proposed protocol for hand and table sanitizing in chiropractic clinics and education institutions. *J Chiropr Med*. 2009;8(1):38-47.
31. Peterson DH, Bergmann TF. *Chiropractic Technique: Principles and Procedures*. 2nd ed. St. Louis, MO: Mosby; 2002.
32. Barnes PM, Bloom B, Nahin RL. Complementary and alternative medicine use among adults and children: United States, 2007. *Natl Health Stat Rep*. 2008;12:1-23.
33. Davis MA, Sirovich BE, Weeks WB. Utilization and expenditures on chiropractic care in the United States from 1997 to 2006: U.S. chiropractors. *Health Serv Res*. 2010;45(3):748-761.
34. Christensen MG, National Board of Chiropractic Examiners. *Practice Analysis of Chiropractic 2015: A Project Report, Survey Analysis, and Summary of the Practice of Chiropractic within the United States*. Greeley, CO: National Board of Chiropractic Examiners; 2015.
35. Evans Jr MW, Ramcharan M, Ndetan H, et al. Hand hygiene and treatment table sanitizing in chiropractic teaching institutions: results of an education intervention to increase compliance. *J Manipulative Physiol Ther*. 2009;32(6):469-476.

36. Evans Jr MW, Breshears J. Attitudes and behaviors of chiropractic college students on hand sanitizing and treatment table disinfection: results of initial survey and focus group. *J Am Chiropr Assoc*. 2007;44(4):13-23.
37. Chamberlain NR, Singh VK. Prevalence of methicillin resistant *Staphylococcus aureus* in nasal samples from preclinical second-year medical students. *Mo Med*. 2011;108(5):373-376.
38. Slifka KJ, Nettleman MD, Dybas L, Stein GE. Is acquisition of methicillin-resistant *Staphylococcus aureus* an occupational hazard for medical students? *Clin Infect Dis*. 2009;49(3):482-483.
39. Miramonti C, Rinkle JA, Iden S, et al. The prevalence of methicillin-resistant *Staphylococcus aureus* among out-of-hospital care providers and emergency medical technician students. *Prehosp Emerg Care*. 2013;17(1):73-77.
40. Lum T, Picardo K, Westbay T, Barnello A, Fine L, Lavigne J. Student self-screening for methicillin-resistant *Staphylococcus aureus* (MRSA) nasal colonization in hand hygiene education. *Am J Pharm Educ*. 2014;78(7):138.
41. Schwartz MD. Nasal carriage of *Staphylococcus aureus* in physician assistant students: initial prevalence and transmission during clinical rotations. *J Physician Assist Educ*. 2011;22(2):30-33.
42. Rohde RE, Patterson T, Covington B, Vásquez BE, Redwine G, Carranco E. *Staphylococcus*, not MRSA? A final report of carriage and conversion rates in nursing students. *Clin Lab Sci*. 2014;27(1):21-31.
43. Macario E, Daum RS, Miller LG, Eells SJ. Using cognitive interviews to refine a household contacts survey on the epidemiology of community-associated methicillin resistant *Staphylococcus aureus*. *J Infect Prev*. 2010;11(2):44-48.
44. Güçlü E, Yavuz T, Tokmak A, et al. Nasal carriage of pathogenic bacteria in medical students: effects of clinic exposure on prevalence and antibiotic susceptibility. *Eur Arch Otorhinolaryngol*. 2007;264(1):85-88.
45. Ishihara K, Shimokubo N, Sakagami A, et al. Occurrence and molecular characteristics of methicillin-resistant *Staphylococcus aureus* and methicillin-resistant *Staphylococcus pseudintermedius* in an academic veterinary hospital. *Appl Environ Microbiol*. 2010;76(15):5165-5174.
46. Piechowicz L, Garbacz K, Wiśniewska K, Dąbrowska-Szponar M. Screening of *Staphylococcus aureus* nasal strains isolated from medical students for toxin genes. *Folia Microbiol (Praha)*. 2011;56(3):225-229.
47. Renushri SA, Nagaraj KV. Inducible clindamycin resistance in *Staphylococcus aureus* isolated from nursing and pharmacy students. *J Lab Physicians*. 2011;3(2):89.
48. Zakai SA. Prevalence of methicillin-resistant *Staphylococcus aureus* nasal colonization among medical students in Jeddah, Saudi Arabia. *Saudi Med J*. 2015;36(7):807-812.
49. Ellis MW, Griffith ME, Dooley DP, et al. Targeted intranasal mupirocin to prevent colonization and infection by community-associated methicillin-resistant *Staphylococcus aureus* strains in soldiers: a cluster randomized controlled trial. *Antimicrob Agents Chemother*. 2007;51(10):3591-3598.
50. Ellis MW, Hospenthal DR, Dooley DP, Gray PJ, Murray CK. Natural history of community-acquired methicillin-resistant *Staphylococcus aureus* colonization and infection in soldiers. *Clin Infect Dis*. 2004;39(7):971-979.
51. Ray GT, Suaya JA, Baxter R. Incidence, microbiology, and patient characteristics of skin and soft-tissue infections in a U. S. population: a retrospective population-based study. *BMC Infect Dis*. 2013;13:252.
52. Creech CB, Saye E, McKenna BD, et al. One-year surveillance of methicillin-resistant *Staphylococcus aureus* nasal colonization and skin and soft tissue infections in collegiate athletes. *Arch Pediatr Adolesc Med*. 2010;164(7):615-620.
53. Buss BF, Connolly S. Surveillance of physician-diagnosed skin and soft tissue infections consistent with methicillin-resistant *Staphylococcus aureus* (MRSA) among Nebraska high school athletes, 2008–2012. *J Sch Nurs*. 2014;30(1):42-48.
54. Ridgway JP, Peterson LR, Brown EC, et al. Clinical significance of methicillin-resistant *Staphylococcus aureus* colonization on hospital admission: one-year infection risk. *PLoS One*. 2013;8(11):e79716.
55. Chapman BP, Weiss A, Fiscella K, Muennig P, Kawachi I, Duberstein P. Mortality risk prediction: can comorbidity indices be improved with psychosocial data? *Med Care*. 2015;53(11):909-915.
56. Crutzen R, Göritz AS. Does social desirability compromise self-reports of physical activity in web-based research? *Int J Behav Nutr Phys Act*. 2011;8:31.
57. Wright DL, Aquilino WS, Supple AJ. A comparison of computer-assisted and paper-and-pencil self-administered questionnaires in a survey on smoking, alcohol, and drug use. *Public Opin Q*. 1998;62(3):331-353.
58. Tourangeau R, Smith TW. Asking Sensitive Questions: the impact of Data Collection Mode, Question Format, and Question Context. *Public Opin Q*. 1996;60(2):275-304.