Published in final edited form as:

Am J Infect Control. 2008 November ; 36(9): 644–650. doi:10.1016/j.ajic.2008.05.005.

Prevalence, Risk Factors and Molecular Epidemiology of Methicillin Resistant *Staphylococcus aureus* Nasal Colonization among Newly Arrested Males in Baltimore, Maryland

J.E. Farley, PhD, MPH, CRNP^{1,2}, T. Ross, BS³, P. Stamper, PhD(c), MPH³, S. Baucom, MD⁴, E. Larson, PhD, RN⁵, and K.C. Carroll, MD^{2,3,6}

¹Johns Hopkins University, School of Nursing, Baltimore, MD

²Johns Hopkins University, School of Medicine, Division of Infectious Disease, Baltimore, MD

³Johns Hopkins Microbiology Laboratory, Baltimore, MD

⁴Maryland Department of Corrections, Baltimore, MD

⁵Columbia University School of Nursing, Baltimore, MD

⁶Johns Hopkins Medical Institutions, Baltimore, MD

Abstract

Background—Outbreaks of MRSA within prison populations seemingly attests to its spread within corrections; however, the extent of MRSA colonization upon arrest is unknown.

Methods—This study determined the prevalence and risk factors of *S. aureus* upon arrest. Nasal swabs from 602 newly arrested men were evaluated. Risk factors were assessed through self-report. Molecular characterization of each isolate was completed.

Results—The prevalence of *S. aureus* nasal colonization was 40.4% (243/602). MRSA colonization was noted in 15.8% (95/602) and 39.1% (95/243) of the total *S. aureus* isolates. Twenty-three skin infections were identified. *S. aureus* infection was noted in 11 (47.8%) with MSSA in 3 (13.1%) and MRSA in 8 (34.8%). In two cases (25%) of MRSA wound infections, the nasal colonizing strain was MSSA. By PFGE, 76 of 95 (80%) nasal isolates were USA300 or related subtypes, 19 of 95 (20%) were non-USA300 strains. PVL was identified in 38 (97.4%) of USA300 strains and 6 (31.6%) isolates of non-USA 300 isolates.

Conclusions—MRSA colonization is far greater in this sample than in the general public. USA300 subtypes are highly prevalent. History of prior arrest was not associated with an elevated MRSA prevalence. MRSA risk factors were significantly different between those with and without prior arrest history.

Since the late 1990's, the emergence of community associated methicillin resistant *Staphylococcus aureus* (CA-MRSA) has been described in diverse community populations throughout the world (1-11). In these studies, CA-MRSA was distinguished from nosocomial MRSA by distinct epidemiologic and molecular differences noted in the organisms,

Corresponding Author: Jason E. Farley, PhD, MPH, CRNP 3511 Rosekemp Avenue Baltimore, MD 21214 H: 410-254-1964 F: 410-955-7733 jfarley@son.jhmi.edu.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

specifically USA 300 pulsed-field gel electrophoresis (PFGE) strain type; presence of Panton-Valentine Leukocidin (PVL); and less antimicrobial resistance (12). Over the last 5 years new data on the evolving epidemiology of *Staphylococcus aureus* (*S. aureus*) and CA-MRSA (11,13) as well as the appearance and transmission of the organism in the healthcare setting (14,15) has blurred this definition.

Correctional facilities provide a unique opportunity for both *Staphylococcus aureus* (*S. aureus*) and MRSA transmission and several documented outbreaks have occurred in recent years. (16-18) Surveillance for MRSA colonization within correctional settings has received little attention until a recent report by Lowy, et al (19) which identified a 10.5% prevalence of MRSA colonization among prisoners in two New York State Correctional Institutions. Jail location was significantly associated with MRSA colonization in this study. The prevalence of MRSA colonization among prisoners undergoing hospitalization in a 13-bed correctional health unit at a large teaching hospital in Baltimore, Maryland was recently described by Wright, et al (20). In this study the authors noted an overall nasal colonization prevalence of 11.5%, with a prevalence of 17.0% if the individual was transferred from a Baltimore City Jail Facility. Based on these and other published data, we now have evidence of MRSA clinical infections inside prisons (16-18) and knowledge that jail setting prior to incarceration may play a role in colonization (19,20). Further, a recent investigation in Chicago uncovered previous incarceration as a significant risk factor for MRSA clinical infections among persons hospitalized or receiving outpatient care (21). Collectively, these findings demonstrate the importance of active surveillance studies to determine if MRSA colonization and/or infection are present upon arrest.

This study has two primary aims: 1) to determine the prevalence of methicillin susceptible and methicillin resistant *S. aureus* nasal colonization and infection in men upon arrest; and 2) to identify risk factors for acquisition of each pathogen. As a secondary aim of this study, we investigated the phenotypic (i.e. antimicrobial susceptibilities) and genotypic [i.e. pulsed-field gel electrophoresis (PFGE) and Panton Valentine Leukocidin (PVL)] characteristics of the isolates to determine if the isolates were hospital or community associated. The data was presented, in part, at the 45th Annual Scientific Meeting of the Infectious Diseases Society of America (IDSA), San Diego, California; October 5th, 2007.

METHODS

Study setting

The study was conducted in the Central Booking Intake Facility in Baltimore, MD from August to December 2006. Central Booking is the main intake center for persons arrested in Baltimore City and processes, on average, 175 new arrestees per day. The researcher was given access between 1pm and 11pm 5 days a week.

Subject selection

Subjects were eligible for participation by meeting the following criteria: (i) arrested <24 h before enrollment, (ii) male, (iii) age 21 years and older and (iv) were processed at the Central Booking Intake Facility in Baltimore, MD. Female arrestees were excluded as a result of correctional staffing limitations.

Collection of clinical specimens

Anterior nasal specimens (NS) were obtained using BactiSwab II dual-headed culturettes (Remel, Lenexa, KS) from 602 of 678 (89%) men who were screened for participation and who provided informed consent. Both swabs were inserted into each nare at the same time. Wound specimens were obtained from 23 of 602 (3.8%). The same nurse practitioner collected

all specimens. All swabs were transported at room temperature and stored at 5°C until processing within 24 h of collection.

Risk factor evaluation

A standardized 50 item questionnaire was designed after reviewing the literature to identify factors that assessed a person's hospital and community risks for MRSA acquisition. The questionnaire also included basic demographic questions that were administered to each participating and non-participating subject as allowed. The jail screening medical record forms were reviewed for clarity as needed. All questionnaires and medical record review was completed by the same nurse practitioner.

Microbiologic evaluation

Using standard culture methods, a swab was streaked onto CHROMagar-MRSA (BD Diagnostics, Inc.) [CHROM-MRSA], a selective medium, and then placed in Trypticase soy broth (TSB) with 6.5% NaCl (22,23). CHROM-MRSA agar plates were incubated in the dark at 35°C and reviewed at 24 hours (h) and again at 48 h, if necessary. Mauve colored colonies were confirmed as *S. aureus* (SA) by Gram's stain and slide coagulation or latex agglutination (Staphaurex Plus [Remel, Lenexa, KS]) (24). Each TSB was sub-cultured after overnight incubation to 5% sheep blood agar (SBA) plates (BBL, BD Diagnostics). The SBA plates were incubated aerobically for 24–48 h at 35°C. Gram positive cocci that were catalase positive and slide coagulase positive were identified presumptively as *S. aureus*. If the matching CHROM-MRSA plates were negative, the SBA isolates were subbed to Oxacillin Screening Agar (OSA) (BD, Sparks, MD) according to the manufacturer's protocol and read at 24 h to determine methicillin susceptibility. Nasal and wound isolates growing on CHROM-MRSA were considered MRSA; whereas, those isolates positive on OSA but not growing on the CHROM-MRSA were confirmed as gram positive cocci in clusters and identification and susceptibility testing authenticated with the BD Phoenix™ Automated Microbiology System (Phoenix) (BD Diagnostics, Sparks, MD) (25). Detection of the PVL gene was completed as described by Lina, et al. (1999) (26).

Statistical Analysis

Sample size was calculated using a conservative estimated MRSA prevalence of 2.5% (alpha .05, 80% power). Student's t-test or X^2 testing was performed for univariate analysis. Relative risk ratios (RRR) and exact 95% confidence intervals (CIs) were also calculated using multinomial logistic regression with likelihood ratio testing for model fit for each variable independently. Variance inflation factors (VIFs) were evaluated for the presence of collinearity with no evidence suggestive of such a finding. Once the final multinomial model was determined, each outcome (i.e. MSSA and MRSA) was separately evaluated in multivariable logistic regression for the presence of interaction and confounding. Statistical analysis was completed using STATA version 9.0 (STATACorp, LP. College Station, TX).

The research was approved by the Maryland Department of Corrections research committee, The Johns Hopkins University Institutional Review Board (IRB) as well as the Office of Human Research Protections within The Department of Health and Human Services. A certificate of confidentiality was obtained from the National Institutes of Health to protect subjects from prosecution due to disclosure of sensitive risk factor information such as self-report of intravenous drug use.

RESULTS

Demographics

Six-hundred seventy eight persons were approached for participation. The enrolled sample consisted of 602 arrested males each providing a nasal swab and wound culture if applicable. Demographic data was also collected on 67 of 75 (89.3%) persons who declined participation, but agreed to collection of demographic information. The remaining 8 subjects refused any participation. Demographic characteristics of the two groups were compared to evaluate bias in sample selection. The two samples were equivalent with regard to race, health status, and residence (Baltimore City versus other location). Educational status was different between the groups with a higher level of educational preparation (i.e. some college or higher) among those who refused to participate (26.9% vs. 18.3%; $p=0.003$). Among study participants, differences in age and health status were identified between the three possible culture outcomes (table 1).

Prevalence and Risk Factors of *S. aureus* Colonization

During the period of study the prevalence of *S. aureus* nasal colonization in this cohort was 40.4% (243/602); 15.8% (95/602) of the overall cohort were colonized with MRSA, 39.1% (95/243) of the *S. aureus* isolates. Univariate analysis revealed several differences between men with and without *S. aureus* colonization. The average proportion of men with *S. aureus* colonization were older ($p=0.009$) and more likely to report the following: fair/poor health ($p=0.043$); chronic skin disease ($p=0.017$); being an active intravenous drug user ($p=0.046$); and having a history of abscess ($p=0.007$). Differences in race, location of residence (i.e. Baltimore City versus other location), self-described health status, or education were not statistically significant between men with and without *S. aureus* colonization (table 2).

Bi-variable multinomial logistic evaluation of risk associated with *S. aureus* colonization (excluding MRSA) identified arrestees who reported having a history of abscess as significantly more likely to harbor methicillin susceptible *S. aureus* (MSSA) (table 3). Persons with MSSA colonization were more likely to be Caucasian and also more likely to report fair/poor health. Despite literature reports of increased *S. aureus* colonization in athletes (3), those healthy enough for routine sports participation were protected against MSSA colonization in this cohort. A history of previous arrest was not associated with MSSA colonization.

Among those with MRSA colonization, the average proportion was greater within the age category of 30 to 49 years (Table 3). Similar to men colonized with MSSA, fair/poor health was associated with MRSA colonization as was a history of abscess. Additional factors associated specifically with MRSA colonization included reports of chronic skin disease, antibiotics in the last 6 months, current abscess on arrest and active intravenous drug use in the last 6 months.

When we evaluated the multivariable multinomial regression analysis of *S. aureus* colonization, Caucasian race (RRR = 1.99; 95% C.I. 1.22 – 3.29, $p=0.006$) as well as persons with a history of abscess (RRR = 1.83; 95% C.I. 1.06 – 3.16, $p=0.000$) remained significant. Like MSSA, a history of abscess was strongly associated with MRSA colonization in this group (RRR = 2.91; 95% C.I. 1.62 – 5.22; $p=0.000$). Additionally, men whose age ranged between 30 – 49 years were more likely to be MRSA colonized (RRR = 2.68; 95% C.I. 1.48 – 4.84; $p=0.001$).

Approximately 40% ($n=243$) of the cohort reported a prior arrest history within the 6 months preceding the current arrest. When the sample was stratified between persons with and without a prior arrest history, several interesting differences were noted. Men colonized with MRSA, but without a prior history of arrest maintained the same exact risk factors noted above (i.e. history of abscess and age range 30 – 49). Men with a prior arrest history were also noted to

have several additional risk factors, two of which were directly associated with prior incarceration activities (table 4).

***S. aureus* Skin and Soft Tissue Infections**

Twenty-three skin and soft tissue infections were reported by enrolled subjects. *S. aureus* infection was noted in 11 (47.8%); MSSA was isolated in 3/11 (13.1%) and MRSA in 8/11 (34.8%). Among the 8 MRSA infected wounds, 5 (62.5%) were colonized with the infecting MRSA strain. In two subjects (25%), the nasal colonizing strain was MSSA; the final subject demonstrated no nasal colonization.

Molecular Characterization of MRSA Isolates

By pulsed-field gel electrophoresis (PFGE), 76 of 95 (80%) nasal isolates were USA300 or related subtypes, 19 of 95 (20%) were non-USA300 strains with no USA 400 isolates noted. Among the wound isolates 5 of the 8 (62.5%) MRSA isolates were USA300 strains.

Polymerase chain reaction (PCR) was completed on a 50% sample of USA300 and all non-USA300 isolates to detect the presence of the Panton-Valentine Leukocidin (PVL) gene. PVL was identified in 38 of 39 (97.4%) of the USA300 and related strains and in 6 of 19 (31.6%) of non-USA 300 isolates. PVL was identified in 7 of 60 (11.7%) *S. aureus* isolates tested. The results of in vitro susceptibility testing are presented in Table 5 and include a >95% susceptibility to trimethoprim-sulfamethoxazole (Bactrim) as well as a high discordance between clindamycin and erythromycin susceptibility suggesting the need to confirm the presence of in vitro inducible macrolide-lincosamide-streptogramin B resistance (iMLS) (D-test) analysis among this patient population (27).

DISCUSSION

This is the first surveillance study to investigate *S. aureus* and MRSA colonization upon arrest to identify the prevalence and risk profiles of persons entering a large city jail system. Both the prevalence of *S. aureus* (40.4%) and MRSA (15.8%) among nasal isolates are substantially greater than estimates from the largest and most representative community analysis of the prevalence of MRSA colonization, to date, which noted a *S. aureus* and MRSA colonization prevalence of 31% and 0.84%, respectively (28). Our findings also reveal a higher prevalence of colonization than noted among New York prisoners who were already serving their sentence (19) which may represent a regional difference or demonstrate a higher prevalence among newly arrested persons compared with incarcerated individuals. Our findings are similar to the prevalence noted upon hospitalization of prisoners originating from Baltimore City Jail Facilities (15.8% versus 17%) (20), demonstrating a high prevalence of CA-MRSA in Baltimore, but these data do not necessarily support acquisition in the jail setting given the similarities in prevalence.

Interestingly, the present study demonstrated no difference in the prevalence among those with and without previous arrest, 16.2% versus 15.2% respectively. This finding is noteworthy given the recent reports demonstrating an increase in risk of clinical infection in persons who were previously incarcerated (21) and may speak to recent data suggesting that nasal colonization with MRSA is not a necessary antecedent to CA-MRSA infection (29). Notable, two (25%) of the subjects with clinical wound infections in this study were colonized with methicillin susceptible *S. aureus*. Data are emerging on the need to culture other anatomic sites in addition to nares (i.e. groin, rectum and axillae) to obtain a true picture of CA-MRSA colonization (30) which may be a limitation in this study.

Despite a similar prevalence between those with and without an arrest history, the risk factors for MRSA colonization were strikingly different. Men without a history of prior arrest demonstrated characteristics consistent with the overall sample. Those reporting a prior arrest were significantly more likely to be MRSA colonized if they routinely used the gym/weight room or had a skin infection during their previous incarceration. These correctional specific risk factors provide insight into mechanisms for transmission within correctional facilities.

USA300 PFGE subtypes and the PVL gene are molecular factors that have been identified as markers of CA-MRSA (12). The present study reveals that the majority of the MRSA isolates identified in this sample, and thus entering the jail, were USA300 or related subtypes 76/95 (80%), with phenotypic characteristics suggesting acquisition within the community. Risk factor analysis within this dataset did not demonstrate any significant hospital associated MRSA risk factors, again supporting community acquisition.

The study identifies the burden a correctional agency faces in limiting intra-facility transmission due to continual entrance of colonized and infected individuals capable of transmitting MRSA. The booking process is often slow and tedious leading to long back-logs of arrestees, waiting in overcrowded holding cells. Isolation cells for persons with known draining or open wounds are typically not available (31). These conditions are likely antecedents to the occurrence of a future outbreak of skin and soft tissue infections related to CA-MRSA. Evidenced-based infection control interventions are needed within these settings to limit such transmission.

Mathematical modeling of an outbreak of CA-MRSA within the Los Angeles County Jail has recently been published (32) and provides insight into the hypothesis of community burden affecting jail transmission. The report identifies the continual entry of newly arrested individuals colonized or infected with MRSA as the primary means of sustaining the outbreak. The derivation of the reproduction number (R_0), average number of secondary infections generated by one infectious case, is eloquently demonstrated in the analysis. The model likely overestimates community associated prevalence by including cultures taken up to 5 days after arrest as part of admission screening. Nevertheless, this model provides a useful tool for characterizing the extent of intra-facility transmission.

The participation rate in our study (89%) was higher than expected. We believe this is likely due to current community knowledge of the primary clinical consequences of this bacterium; so called “spider-bites” or “boils”. Many participants reported having or knowing a person who recently experienced such an issue. All participants were instructed that participation was not mandatory. Further, we attempted to control for selection bias in this study by consistently offering enrollment to all arrestees as part of their medical screening. Nonetheless, it is possible that persons with a known history of MRSA or active skin infection were more likely to refuse participation in the study to avoid being identified. We believe it is unlikely for the participants to have become colonized with MRSA during the arrest process, as they are generally handcuffed during transport without the potential for hand-to-nose contact. There may be a difference in colonization rates among persons who are arrested and processed before 1pm and after 11pm, although arrests occurred at random throughout the city. Finally, our study was unable to recruit female arrestees, limiting the generalizability of our data beyond male arrestees. Female inmates have been shown in several studies (17,19,33) to have a higher frequency of MRSA colonization, therefore, their inclusion may have increased the overall MRSA prevalence in this study. The overall burden of MRSA among new arrestees, as a population, is likely to be greater than our current estimation.

Our findings have broad implications for correctional settings. The prevalence of MRSA in men upon arrest is much higher than the general population. Infection control professionals

and other correctional health personnel must consider *S. aureus* and MRSA an ongoing threat to the health and well-being of the correctional population and correctional staff. Risk reduction strategies targeting the prevention of future outbreaks are required in both the jail and prison settings. Evaluation of low cost prevention strategies within the correctional environment is an urgently needed area of future research.

Acknowledgments

We would like to thank the wardens and correctional officers at the Baltimore City Central Booking Intake Facility for their assistance and professionalism during this study. Drs. Karen Carroll and Gayle Page for their guidance and mentorship during this endeavor. David Dial for his insight and expertise in the development of the ACCESS database and thoughtful editorial review of the manuscript.

Financial support. This research received support from a National Research Service Award (NRSA) funded by the National Institute of Nursing Research (NINR), National Institute of Health (NIH) - Grant # 1 F31 NR009334-01 as well as an NIH funded T-32 Institutional Training grant in Health Disparities. The laboratory work was supported in part by a grant from BD Diagnostics (Sparks, MD) and BD GeneOhm (San Diego, CA).

References

1. Charlebois E, Bangsberg D, Moss N, et al. Population-based community prevalence of methicillin-resistant *Staphylococcus aureus* in the urban poor of San Francisco. *Clinical Infectious Disease* 2003;34:425–433.
2. Centers for Disease Control and Prevention. Outbreaks of community-associated MRSA skin infections – Los Angeles County, California, 2002–2003. *MMWR* 2003;88.
3. Centers for Disease Control and Prevention. MRSA infections among competitive sports participants – Colorado, Indiana, Pennsylvania and Los Angeles, 2000–2003. *MMWR* 2003;52(33):793–795. [PubMed: 12931079]
4. Herold BC, Immergluck LC, Maranan MC, et al. Community-acquired methicillin-resistant *Staphylococcus aureus* in children with no identified predisposing risk. *JAMA* 1998;279:593–8. [PubMed: 9486753]
5. Adcock PM, Pastor P, Medley F, et al. MRSA in two child-care centers. *The Journal of Infectious Disease* 1998;178:577–580.
6. Groom AV, Wolsey DH, Naimi TS, et al. CA-MRSA in a rural American Indian community. *JAMA* 2001;286(10):1201–1205. [PubMed: 11559265]
7. Baggett HC, Hennessy TW, Leman R. An outbreak of community onset MRSA skin infections in southwestern Alaska. *Infection Control and Hospital Epidemiology* 2003;24(6):397–402. [PubMed: 12828314]
8. Borer A, Gilad J, Yagupsky P, et al. CA-MRSA in institutionalized adults with developmental disabilities. *Emerging Infectious Diseases* 2002;8(9):966–970. [PubMed: 12194775]
9. Crum-Cianflone NF, Burgi AA, Hale BR. Increasing rates of community-acquired methicillin-resistant *Staphylococcus aureus* infections among HIV-infected persons. *International Journal of STD and AIDS* 2007;18(8):521–6. [PubMed: 17686212]
10. Bratu S, Landman D, Gupta J, Trehan M, Panwar M, Quale J. A population-based study examining the emergence of community-associated Methicillin-resistant *Staphylococcus aureus* UDA300 in New York City. *Annals of Clinical Microbiology and Antimicrobial Therapy* 2006;30(5):29.
11. Huang YH, Tseng SP, Hu JM, Tsai JC, Hsueh PR, Teng LJ. Clonal spread of SCCmec type IV methicillin-resistant *Staphylococcus aureus* between community and hospital. *Clinical Microbiology and Infection* 2007;13(7):717–724. [PubMed: 17403129]
12. Baba T, Takeuchi F, Kuroda M, Yuzawa H, Aoki K, Oguchi A, et al. Genome and virulence determinants of high virulence community-acquired MRSA. *Lancet* 2002;359:1819–1827. [PubMed: 12044378]
13. Mwangi MM, Wu SW, Zhou Y, Sieradzki K, de Lencastre H, Richardson P, Bruce D, Rubin E, Myers E, Siggia ED, Tomasz A. Tracking the in vivo evolution of multidrug resistance in *Staphylococcus aureus* by whole-genome sequencing. *Proceedings of the National Academy of Science* 2007;104(22):9451–6.

14. Saiman L, O'Keefe M, Graham PL. Hospital transmission of community-acquired methicillin-resistant *Staphylococcus aureus* among postpartum women. *Clinical Infectious Disease* 2003;37(10):1313–9.
15. Bratu S, Eramo A, Kopec R, Coughlin E, Ghitan M, Yost R, Chapnick EK, Landman D, Quale J. Community-associated methicillin-resistant *Staphylococcus aureus* in hospital nursery and maternity units. *Emerging Infectious Disease* 2005;11(6):808–13.
16. Centers for Disease Control and Prevention. Methicillin-resistant *Staphylococcus aureus* infections in correctional facilities – Georgia, California and Texas, 2001–2003. *MMWR* 2003;52(41):992–996. [PubMed: 14561958]
17. Centers for Disease Control and Prevention. Methicillin-Resistant *Staphylococcus aureus* skin or soft tissue infections in a state prison – Mississippi, 2000. *MMWR* 2001;50(42):919–922. [PubMed: 11699844]
18. Pan ES, Diep BA, Carleton HA, Charlebois ED. Increased prevalence of methicillin-resistant *Staphylococcus aureus* infection in California jails. *Clinical Infectious Disease* 2003;37(10):1384–1388.
19. Lowy FD, Aiello AE, Bhat M, Johnson-Lawrence VD, Lee MH, Burrell E, Wright LN, Vasquez G, Larson EL. *Staphylococcus aureus* colonization and infection in New York State prisons. *Journal of Infectious Disease* 2007;196(6):911–8.
20. Wright MO, Furuno JP, Venezia RA, Johnson JK, Standiford HC, Hebden JN, Hill J, Hartley DM, Harris AD, Perencevich EN. Methicillin-resistant *Staphylococcus aureus* infection and colonization among hospitalized prisoners. *Infection Control and Hospital Epidemiology* 2007;28(7):877–9. [PubMed: 17564994]
21. Hota B, Ellenbogen C, Hayden MK, Aroutcheva A, Rice TW, Weinstein RA. Community-associated methicillin-resistant *Staphylococcus aureus* skin and soft tissue infections at a public hospital: do public housing and incarceration amplify transmission? *Arch Intern Med* 2007;167(10):1026–33. [PubMed: 17533205]
22. BBL™ CHROMagar™ MRSA. 2006 [February 3, 2007]. Package insert. at: <http://www.bd.com/ds/productCenter/215084.asp>
23. Flayhart D, Hindler JF, Bruckner DA, Hall G, Shrestha RK, Vogel SA, Richter SS, Howard W, Walther R, Carroll KC. Multicenter evaluation of BBL CHROMagar MRSA medium for direct detection of methicillin-resistant *Staphylococcus aureus* from surveillance cultures of the anterior nares. *J. Clin. Microbiol* 2005;44:5536–40. [PubMed: 16272482] StataCorp: Stata Statistical Software: Release 9.0, Stata Corporation, College Station, TX, (2005).
24. Weist K, Cimbal AK, Lecke C, Kampf G, Ruden H, Vonberg RP. Evaluation of six agglutination tests for *Staphylococcus aureus* identification depending upon local prevalence of methicillin-resistant *S. aureus* (MRSA). *J. Med. Microbiol* Mar;2006 55(Pt 3):283–90. [PubMed: 16476792]
25. Carroll KC, Borek AP, Burger C, Glanz B, Bhally H, Henciak S, Flayhart. DC. Evaluation of the BD Phoenix automated microbiology system for identification and antimicrobial susceptibility testing of staphylococci and enterococci. *J. Clinical Microbiology* 2006;44:2072–7.
26. Lina G, Piemont Y, Godail-Gamot F, Bes M, Peter MO, Gauduchon V, et al. Involvement of Panton-Valentine leukocidin-producing *Staphylococcus aureus* in primary skin infections and pneumonia. *Clinical Infectious Diseases* 1999;29:1128–1132. [PubMed: 10524952]
27. Siberry GK, Tekle T, Carroll K, Dick J. Failure of clindamycin treatment of methicillin-resistant *Staphylococcus aureus* expressing inducible clindamycin resistance in vitro. *Clinical Infectious Diseases* 2003;37(9):1257–60. [PubMed: 14557972]
28. Graham PL, Lin SX, Larson E. A U.S. population based survey of *S. aureus* colonization. *Annals of Internal Medicine* 2006;144(5):318–326. [PubMed: 16520472]
29. Zafar U, Johnson LB, Hanna M, Riederer K, Sharma M, Fakih MG, Thirumoorthi MC, Farjo R, Khatib R. Prevalence of nasal colonization among patients with community-associated methicillin-resistant *Staphylococcus aureus* infection and their household contacts. *Infection Control and Hospital Epidemiology* 2007;28(8):966–9. [PubMed: 17620245]
30. Rosenthal A, White D, Churilla S, Brodie S, Katz KC. Optimal surveillance culture sites for detection of methicillin-resistant *Staphylococcus aureus* in newborns. *Journal of Clinical Microbiology* 2006;44(11):4234–6. [PubMed: 16957041]

31. Bick JA. Infection control in jails and prisons. *Clinical Infectious Disease* 2007;45e-publication
32. Kajita E, Okano JT, Bodine EN, Layne SP, Blower S. Modelling an outbreak of an emerging pathogen. *Nature Reviews Microbiology* 2007;5(9):700–709.
33. Baillargeon J, Kelley MF, Leach CT, Baillargeon G, Pollock BH. Methicillin-resistant *Staphylococcus aureus* infection in the Texas prison system. *Clinical Infectious Disease* 2004;38(9):e92–5.

Table 1
Demographic Characteristics Among New Arrestees with and without *S. aureus* colonization

Risk Factor (N=602)	<i>S. aureus</i> Negative	MSSA	MRSA	p-value *
Baseline Demographics				
	n = 359 n (%)	n = 148 n (%)	n = 95 n (%)	
Age				
21–29	120 (33.4)	39 (26.4)	17 (17.9)	0.009
30–49	192 (53.5)	89 (60.1)	70 (73.7)	
50+	47 (13.1)	20 (13.5)	8 (8.4)	
Race				
African American, not Hispanic	286 (79.7)	102 (68.9)	69 (72.6)	0.088
Caucasian, not Hispanic	51 (14.2)	35 (23.7)	20 (21.1)	
Other	22 (6.1)	11 (7.4)	6 (6.3)	
Zip Code of Residence				
Baltimore City	307 (85.5)	116 (78.4)	83 (87.4)	0.086
Other	52 (14.5)	32 (21.6)	12 (12.6)	
Education				
Did not finish high school	124 (34.5)	48 (32.4)	34 (35.8)	0.344
High school graduate	162 (45.1)	78 (52.7)	46 (48.4)	
Some college	62 (17.3)	15 (10.1)	11 (11.6)	
College graduate	11 (3.1)	7 (4.7)	4 (4.2)	
Health Status				
Excellent or good	244 (67.9)	87 (58.8)	54 (56.8)	0.043
Fair or poor	115 (32.1)	61 (41.2)	41 (43.2)	

* Chi-squared analysis; MSSA - methicillin susceptible *S. aureus*; MRSA - methicillin resistant *S. aureus*; significant p-values highlighted in gray

Table 2

Comparison of Self-Reported Risk Factors by Culture Outcome within 6 Months of Arrest

	Negative n (%)	MSSA n (%)	MRSA n (%)	p-value
Admitted to hospital	71 (19.8)	24 (16.2)	25 (26.3)	0.156
Smoking	263 (73.3)	103 (69.6)	75 (78.9)	0.275
Chronic skin disease	29 (8.1)	14 (9.5)	17 (17.9)	0.017
Chronic steroid use	10 (2.8)	4 (2.7)	1 (1.1)	0.617
Chronic injectable medication	5 (1.4)	4 (2.7)	2 (2.1)	0.591
Intravenous drug user	51 (14.2)	29 (19.6)	23 (24.2)	0.046
HIV positive	17 (4.7)	9 (6.1)	4 (4.2)	0.762
Antibiotics for any reason	72 (20.1)	32 (21.6)	29 (30.5)	0.090
Household member arrested	49 (13.7)	14 (9.5)	15 (15.8)	0.296
Sports participation	85 (23.7)	23 (15.5)	19 (20.0)	0.119
Use of gym facility	21 (5.6)	9 (6.1)	8 (8.4)	0.651
Physical altercation	56 (15.6)	19 (12.8)	20 (21.1)	0.228
Child in Daycare	158 (44.0)	54 (36.5)	35 (36.8)	0.195
Household member in hospital	46 (12.8)	21 (14.2)	12 (12.6)	0.906
Current Abscess	16 (4.5)	9 (6.1)	10 (10.5)	0.079
Previous Abscess	32 (8.9)	22 (14.9)	19 (20.0)	0.007
Household abscess	20 (5.6)	14 (9.5)	8 (8.4)	0.246
Previous Arrest	148 (41.2)	58 (39.2)	37 (38.9)	0.872
Sexual contact	290 (80.8)	118 (79.7)	78 (82.1)	0.900
Sex with commercial sex worker	19 (5.3)	12 (8.1)	3 (3.2)	0.238

*Chi-squared analysis; MSSA - methicillin susceptible *S. aureus*; MRSA - methicillin resistant *S. aureus*; significant p-values highlighted in gray

Table 3Results of Bi-variate Multinomial Logistic Regression for *S. aureus* Colonization of New Arrestees

Risk Factors for Methicillin susceptible <i>S. aureus</i> Colonization	Relative Risk Ratio	95% Confidence Interval (C.I.)	p-value
African American versus Caucasian	1.92	1.18 – 3.13	0.008
Fair/Poor Health	1.22	1.00 – 1.49	0.049
Sports Participation	0.59	0.36 – 0.98	0.043
History of abscess (current/previous)	1.78	1.05 – 3.03	0.033
Risk Factors for Methicillin resistant <i>S. aureus</i> Colonization	Relative Risk Ratio	95% Confidence Interval (C.I.)	p-value
Age Category 30 – 49	2.57	1.45 – 4.58	0.001
Fair/Poor Health	1.27	1.01 – 1.60	0.043
Chronic Skin Disease	2.48	1.30 – 4.74	0.006
Antibiotic in last 6 months	1.75	1.05 – 2.91	0.030
Current abscess on arrest	2.52	1.11 – 5.76	0.028
History of abscess (current/previous)	2.84	1.62 – 4.99	0.000
Intravenous Drug Use in last 6 months	1.93	1.11 – 3.36	0.020

*All risk factors presented in Table 2 were included in model; only significant findings are presented here.

Table 4Risk Factors of Methicillin Resistant *S. aureus* (MRSA) Colonization in Men with a Prior Arrest History

History or Prior Arrest (n=243) MRSA Prevalence 37/243 = 15.2%	Relative Risk Ratio	95% Confidence Interval (C.I.)	p-value
Age Category 30 – 49	4.10	1.47 – 11.43	0.007
Hospital admit within 6 months of arrest	2.91	1.22 – 6.93	0.016
Household abscess within 6 months of arrest	3.95	1.00 – 15.56	0.049
Skin infection during previous incarceration	9.15	1.77 – 47.20	0.008
Use of prison weight room/gym during previous incarceration	4.48	1.20 – 17.20	0.029

Table 5
Antimicrobial Susceptibilities of *S. aureus* Isolates

	MRSA USA 300 (n=76)	MRSA non-USA 300 (n=19)	MSSA (n=148)
Antimicrobial	% Susceptible	% Susceptible	% Susceptible
Erythromycin	10.5	63.2	71.6
Clindamycin	88.2	94.7	96.6
Gentamicin	98.7	89.5	100.0
Moxifloxacin	10.5	63.2	100.0
Nitrofurantoin	100.0	100.0	100.0
Oxacillin	0.0	15.8	100.0
Rifampin	100.0	100.0	100.0
Tetracycline	97.4	84.2	98.6
Trimethoprim_sulfa	97.4	84.2	97.3
Vancomycin	100.0	100.0	100.0

Trimethoprim_sulfa = trimethoprim-sulfamethoxazole; non-USA 300 includes USA 100, 500, 700 and unique strains