Long-Term Follow-Up of Methicillin-Resistant Staphylococcus aureus Molecular Epidemiology after Emergence of Clone USA300 in San Francisco Jail Populations

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We performed a longitudinal analysis of 502 unique methicillin-resistant Staphylococcus aureus (MRSA) clinical isolates originating from San Francisco jail inmates between 2000 and 2007. Strain USA300, first encountered in 2001, accounted for 82.1% (412/502) of MRSA infections. Non-USA300 MRSA strains were rarely found after 2005 (one isolate in 2006, three in 2007).

Since 2001, a dramatic increase in the number of methicillin-resistant Staphylococcus aureus (MRSA) infections has been observed in the United States, mostly related to the emergence of the USA300 clone in the community (3, 6) and, subsequently, in hospitals (21). Correctional facility inmates were among the first communities in which outbreaks of MRSA USA300 were reported in Mississippi (5), Georgia (4), Texas (2), California (19), New York (15), and Canada (1, 16). Thus far, no long-term data are available to describe the evolution of MRSA epidemiology since USA300 was introduced into these institutions. USA300 was first encountered in San Francisco in 2001 (3). We performed a longitudinal analysis of all clinical MRSA isolates originating from San Francisco jail inmates during the years 2000 to 2007.

The San Francisco County jail system houses an average daily population of 2,200 inmates in five jails (20). A retrospective review was conducted of the electronic records for all cultures during the years 2000 to 2007. MRSA isolates originating from San Francisco jail inmates 2001 (3). We performed a longitudinal analysis of all clinical MRSA isolates originating from San Francisco jail inmates during the years 2000 to 2007.

The San Francisco County jail system houses an average daily population of 2,200 inmates in five jails (20). A retrospective review was conducted of the electronic records for all cultures positive for S. aureus that were performed in the San Francisco General Hospital Clinical Microbiology Laboratory, which receives specimens from the Jail Health Services. Aside from the specimen source, collection date, sex, and age, no clinical information was accessible. Data collection was approved by the Committee on Human Research, Office of Research Administration, at the University of California, San Francisco, CA. Isolates were tested for oxacillin resistance by the salt agar method, and the presence of the mecA gene was confirmed by PCR. Susceptibility to other antimicrobial agents was tested using broth microdilution with the MicroScan WalkAway 96 instrument (Dade Behring), and the results were interpreted in accordance with NCCLS guidelines (M7-A5). Samples obtained for colonization screening were excluded. Only one isolate per patient per year was studied. MRSA isolates were genotyped by pulsed-field gel electrophoresis following SmaI macrorestriction digest of chromosomal DNA (23). spa typing (22), and multilocus sequence typing (8). USA300 was further defined by the presence of Panton-Valentine leukocidin genes (lukF-PV and lukS-PV) and the arginine catabolic mobile element by using PCR assays. The SCCmec type was identified using a PCR-based protocol (18). Chi-square tests were used for bivariate analysis, and chi-square tests for trends were used to evaluate secular trends. All statistical calculations were carried out using Stata version 9.1 (College Station, TX).

Between 2000 and 2007, 656 cultures positive for S. aureus were recorded. Of these, 510 (77.7%) were MRSA. Eight MRSA isolates were excluded, because they were obtained by colonization screening (n = 7) or were not available for typing (n = 1). Thus, 502 MRSA isolates were analyzed, originating from 494 patients, with a median age of 39 years (interquartile range, 32 to 47) and a male-to-female ratio of 3.9. There was a significant increase in the incidence of MRSA infections over time (P = 0.01), from 25 in 2000 to 60 in 2007, while the incidence of methicillin-susceptible S. aureus (MSSA) infections remained stable at 20 isolates per year. Of the 502 MRSA isolates analyzed, 412 (82.1%) were USA300 (ST8, SCCmec type IVa), 34 (6.8%) were USA1100 (ST8, SCCmec type IVa), 27 (5.4%) were USA500 (ST8, SCCmec type IVa), 16 (3.2%) were USA1000 (ST59, SCCmec type IVa), and 3 were USA1000 (ST5, SCCmec type II). USA300 appeared in 2001, accounting for 8 of 22 MRSA isolates (36.4%) that year. Its incidence peaked at 128/140 isolates (91.4%) in 2004 and stabilized at 45 to 60 per year from 2005 to 2007, suggesting that USA300 has become endemic in San Francisco jails (Fig. 1). Non-USA300 MRSA isolates were rarely found after 2005 (1 of 47 isolates in 2006, 3 of 60 in 2007). MRSA was mostly isolated from skin or skin structure infections (SSSI) through-the-out study period (mean rate, 92.9% of all specimens). No significant changes in antimicrobial resistance were observed over time for MRSA, with a mean resistance rate at 46.8% for ciprofloxacin, 15.7% for tetracycline, 9.3% for clindamycin, 0.7% for trimethoprim-sulfamethoxazole, and 0.0% for vancomycin and linezolid.

Although previous reports have described community-associated MRSA (CA-MRSA) outbreaks in jails (4, 5, 16), performed colonization surveillance cultures (16, 25), or studied risk factors for MRSA in these settings (1, 2, 24, 25), they focused on limited periods of time. This study shows that, 5 years after its emergence in San Francisco jails, USA300 has replaced virtually all previously encountered CA-MRSA clones. As previously reported (14, 17), USA300 was primarily associated with SSSI in this study and...
was usually susceptible to trimethoprim-sulfamethoxazole, clindamycin, and tetracycline (3), with no significant increase in antimicrobial resistance over time, as opposed to recent reports from other settings (7, 10). Large jails have been identified as likely foci for the amplification and subsequent spread of MRSA in the surrounding communities (12, 13), and it was predicted that public health interventions directed at these “superspreader institutions” could have a disproportionate impact on controlling CA-MRSA epidemics (11). Our study adds another incentive for improving infection control in these institutions by showing the persistently high incidence of MRSA infections once USA300 is introduced, in the absence of dedicated intervention. Guidelines aiming at reducing CA-MRSA transmission in communities are available (9), and significant reductions in MRSA transmission have been achieved in correctional facilities, through a comprehensive intervention program, in Georgia (24).

This study was limited by its reliance on retrospective data collection and the absence of active surveillance cultures. However, as the incidence of positive cultures for MSSA remained stable, it is unlikely that profound changes in sampling policies occurred during the study period. Only documented MRSA infections could be analyzed, although most patients presenting with SSSI in such facilities are treated without microbiological sampling (15). Thus, these figures likely represent an underestimate of the true incidence of MRSA infections. Despite these limitations, this study shows that USA300, 5 years after its introduction into San Francisco jails, has virtually replaced all previous MRSA clones and is associated with a two- to three-times-higher incidence of MRSA infections than the pre-USA300 era.

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