



COMMUNITY-ASSOCIATED METHICILLIN RESISTANT *STAPHYLOCOCCUS AUREUS* IN THE LOS ANGELES COUNTY JAIL: A 4-YEAR REVIEW

BACKGROUND

Methicillin resistant *Staphylococcus aureus* (MRSA) is well known as a nosocomial (healthcare acquired) pathogen. However, since the 1990s, MRSA has been increasingly recognized as a community pathogen. Community associated MRSA (CAMRSA) is distinguished from healthcare associated MRSA (HAMRSA) by clinical and molecular characteristics—HAMRSA is associated with invasive disease (pneumonia, bloodstream infections, surgical site infections) in older persons who have significant exposure to healthcare while CAMRSA causes mostly skin and soft tissue infections, which are often misdiagnosed as “spider bites.” CAMRSA tends to be sensitive to many oral antibiotics whereas HAMRSA, especially in intensive care units, may only be sensitive to intravenous antibiotics. CAMRSA is further distinguished from HAMRSA by the presence of genes for Panton-Valentine leukocidin (PVL), a potent toxin that causes tissue necrosis, and is associated with skin inflammation. Furthermore, CAMRSA and HAMRSA have distinctly different pulsed-field gel electrophoresis (PFGE) patterns, indicating that they derived from different strains of *S. aureus*.

Outbreaks of CAMRSA have been frequently documented in sports teams, the military and correctional facilities where close, crowded living conditions, sharing personal items, and suboptimal hygiene prevail. Outbreaks in correctional facilities are particularly important because in 2004 more than 2 million people were held in correctional facilities in the United States and were therefore at increased risk for acquiring this disease. Despite several reports of CAMRSA in correctional facilities, there are few reports describing the changing epidemiologic trends in this environment. Here we describe four years of epidemiologic trends of MRSA infections in the Los Angeles County Jail—the largest jail in the United States.

Inmates at the Los Angeles County Jail (LACJ) started to complain of “spider bites” in September 2001. In response, the Jail Medical Services instituted a “spider bite” protocol that consisted of, in part, culturing the lesion and treating the inmate an oral antibiotic, an antihistamine, and painkillers. MRSA was first identified in such lesions in February 2002. Several spiders were captured in the spring of 2002 and identified as non-biting species by the Los Angeles County Department of Health Services (LACDHS) entomologist, but nonetheless, the LACJ applied pesticides to inmate quarters. When application of pesticides did not abate the cases of MRSA skin infections, LACJ contacted the ACDC. An investigation was launched to determine the incidence of newly acquired MRSA in the inmate population; treatment and control measures were also recommended.

METHODS

Setting: The LACJ is comprised of seven facilities, of which only one is dedicated to women. Male inmates are routinely transferred between facilities for security purposes. LACJ primarily uses one hospital for all hospital care (reference hospital “A”). From 2000–2004, there were 162,406–179,314 admissions per year. The average daily inmate population fell from ~20,000 (19,297) in 2000 to 17,451 in 2004 primarily because of early release programs instituted during this time. Hygiene standards are regulated by Title 15 of the California Code of Regulations which require that inmates be offered the opportunity to shower three times a week and new underwear be offered twice a week while new jumpsuits and bedding need only be offered once a week. During this time period, females lived primarily in large, open dorms with access to showers 18 or more hours per day. Males lived in a combination of open dorms with daily access to showers and 4–6 man cells with limited shower privileges.

Epidemiologic Investigation: An incident case was defined as an inmate of the LACJ who had a MRSA positive culture from a wound site or blood specimen from January 2002 through December 2005. Cases were identified by staff at LACJ and from a monthly list of positive culture results from the LACJ reference laboratory that processed all cultures taken on non-hospitalized inmates. Cases diagnosed at a referral



hospital used by the LACJ (hospitalized inmate cases) were recorded separately and are not part of this analysis. Inmates with more than one positive MRSA culture during a LACJ admission were counted as an incident case in the first month a positive culture was recorded and subsequent positive MRSA cultures from the same inmate were not recorded as incident cases though additional wound sites and antibiotic susceptibility results were abstracted.

Reference laboratory reports were used to identify the susceptibilities of the MRSA isolates to the following antibiotics: gentamicin, trimethoprim-sulfamethoxazole (TMP-SMX), clindamycin, erythromycin, vancomycin, and tetracycline. In addition, personnel at LACJ provided the following demographic and supplemental information: birth date, gender, admit date to the Jail, Jail facility at the time of culture, culture date, wound site, and antibiotic treatment. Race/ethnicity was a variable added in mid-2005. LACJ personnel also provided data regarding the total number of admissions to the Jail each year.

Cases were analyzed by month of culture date, gender, age, race/ethnicity, wound site, LACJ facility at the time of culture, and by time (in days) between admission to the Jail and date of culture. Cases cultured ≤ 5 days after the date of admission to LACJ are presumed to have acquired their infections from the community and those cultured >15 days are presumed to have acquired while in LACJ. Antibiotic susceptibility trends for MRSA skin and soft tissue cultures were analyzed yearly.

Data were entered into an Access 2002 database and were analyzed using SAS version 9.1. Analyses are presented as whole numbers and percentages.

Laboratory Investigation: In 2002, randomly selected MRSA isolates from outpatient (n=7) and hospitalized (n=5) inmates with wound infections were analyzed by PFGE at the Los Angeles County Public Health Laboratory and compared to a national database of MRSA isolates.

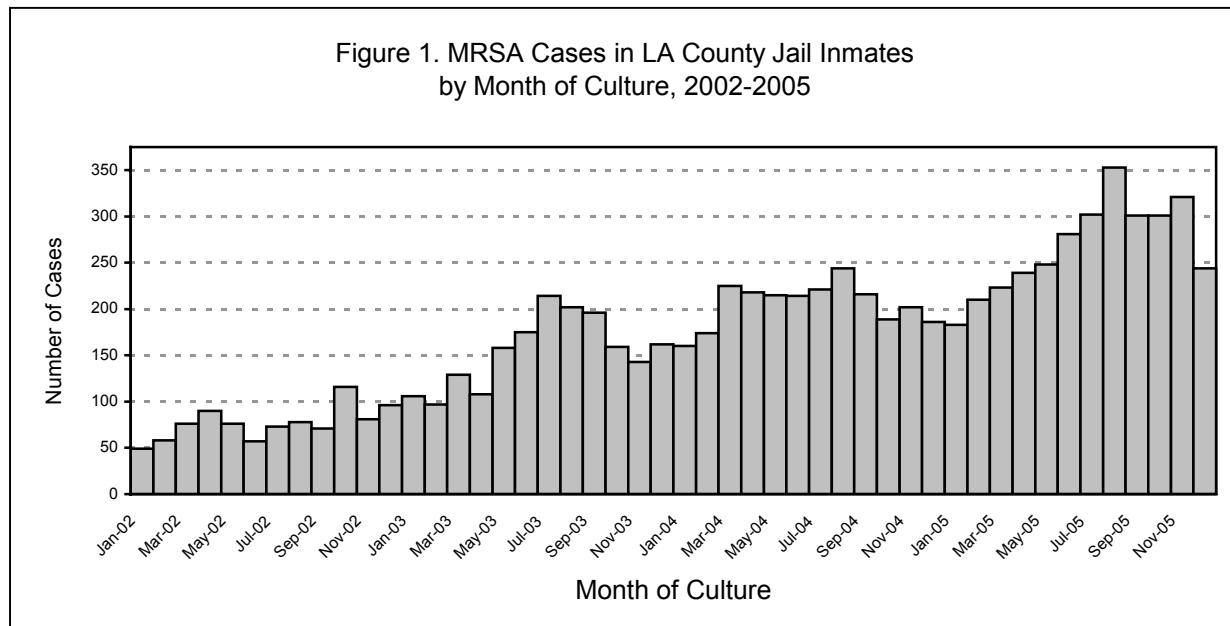
Infection Control: In August 2002, LACDHS issued the following recommendations: screen inmates on admission to the Jail for skin lesions; culture all inmates with skin infections; use empiric antibiotics (if needed) for skin infections that cover MRSA including clindamycin or TMP-SMX; double the laundry exchanges, increase environmental cleaning, and educate inmates and guards about MRSA. Targeted education about MRSA was developed by LACJ and ACDC. These recommendations were supplemented with monthly (later bi-monthly) task force meetings with LACJ and ACDC personnel.

RESULTS

Epidemiology: A total of 921 cases in 2002, 1,849 in 2003, 2,464 in 2004, and 3,214 in 2005 were identified (Figure 1). The incidence of MRSA cases in men increased from 6.1/1000 jail admissions in 2002 to 13.8 in 2005. The incidence of MRSA cases in women increased from 4.3/1000 jail admissions in 2002 to 12.0 in 2005, peaking at 13.8 in 2004 (Table 1). The mean age of cases was 36 years (median 36 years, and range: 17–86 years). The majority (83%) of cases were male. There were no differences in age between male and female cases. Both age and gender distributions were stable over the four years of surveillance. Since mid-2005, most cases were Black (36%), followed closely by Latino (34%), then White (29%). More male cases were Latino than White (36% v. 26%) whereas more female cases were White than Latino (39% v. 26%).

Year	Male	Female
2002	6.1	4.3
2003	11.1	10.6
2004	13.5	13.8
2005 [†]	13.8	12.0

* Number per every 1,000 admissions.
[†] Data unavailable for July, October through December.



Trends in the acquisition of outpatient MRSA varied over time. The percentage of infections identified >15 days after admission to LACJ (and hence presumed to be acquired in the LACJ) decreased from 76% in 2002 to 41% in 2005; whereas the percentage of infections assumed acquired from the community (those identified ≤5 days) increased from 9% to 36%. However, the total number of jail-acquired cases increased each year from 2002 to 2005 (553 cases to 1729 cases). By the end of 2005, both the number and proportion of community-acquired and jail-acquired MRSA infections approached parity. Acquisition patterns varied by gender—CAMRSA infections were usually identified earlier in female inmates than in male inmates. By the end of 2005, about half (51%) of the female cases were identified in the first 5 days after admission, versus 43% of the cases in male inmates.

Though the overall number of cases of MRSA in the LACJ increased, the absolute number of cases entering from the community increased faster than the absolute number of cases acquired in the facility. Furthermore, the number of cases in inmates diagnosed at referral hospital A increased by 7% from 2004 to 2005 (104 to 111 cases) compared to a 30% increase in the number of cases diagnosed at the LACJ in those years, suggesting that many of the cases identified in 2005 at the LACJ were relatively minor or that LACJ personnel were able to identify cases earlier in their course and provide adequate treatment, forestalling hospital admission treatment.

A seasonal trend in MRSA incidence emerged. Beginning in 2002, case counts peaked during the summer months (July or August) and declined between November and March (Figure 1). Three other peaks in the data are notable including October 2002, March 2003, and March-April, 2004. During these peak months, personnel from LACDHS provided education to healthcare personnel at the LACJ, including reinforcing the recommendation to culture all wound infections. The peaks in cases that month may reflect better surveillance for cases.

MRSA infections were identified on all areas of the body. The predominant locations were legs and feet (30%), followed by arms and hands (23%). MRSA isolates have remained susceptible to clindamycin, rifampin, and TMP-SMX, ranging from 94% to 99% susceptibility since 2002 (Table 2). Of note, there was an increasing susceptibility to tetracycline over the surveillance period.

In 2002, over 50% of incident wound infections each month cultured positive for MRSA and the percent of incident *S. aureus* infections by month that were due to MRSA varied between 66% and 84%. Analyzing



available aggregate data in 2002–2004, the percent of wound infections and percent of *S. aureus* that were methicillin resistant (i.e., MRSA) were 56–65% and 73–78% respectively.

Antibiotic	Year			
	2002	2003	2004	2005
Clindamycin	97	97	96	94
Tetracycline	65	76	82	84
TMP-SMX	98	99	99	99
Rifampin	100	99	99	99

Molecular Epidemiology: PFGE results demonstrated one predominant strain seen in all cases, the USA 300-0114 CAMRSA strain. This strain was also seen in several other MRSA skin infection outbreaks since 2002 in Los Angeles County including among men who have sex with men, an athletic team, and hospital newborn nurseries.

DISCUSSION

This summary provides a review of the largest outbreak of CAMRSA known to date. More than 1% of the population in the LACJ acquired a CAMRSA infection each year, more than the current estimate of a general population prevalence of CAMRSA colonization of 0.5%–1%. While the overall number of infections has continued to rise over the four years, there are notable trends that indicate that infection control measures have slowed the growth of jail-acquired CAMRSA. First, the greatest increase in the rate of MRSA occurred from 2002 to 2003 when increased surveillance, not just increased disease incidence, may have accounted for much of that increase. While the number of LACJ identified infections increased by 30% from 2004 to 2005, the number of infections identified by the reference hospital in inmates increased only by 7%. Furthermore, there was a more rapid increase in the number of infections coming from the community in the past 4 years (those identified within 5 days of admission to the LACJ) than the number of jail-acquired infections (identified >15 days after admission to the LACJ). The increase of community acquired MRSA infections is not surprising since it has been noted that the proportion of skin infections seen in a Los Angeles County emergency room due to MRSA increased from 29% in 2001 to 64% in 2004. Others in California have documented CAMRSA in homeless and drug using populations and these populations are disproportionately represented among LACJ inmates. The continually increasing number of infections coming from the community will challenge strategies to control MRSA in the LACJ.

Our analysis employed a cut-off of 5 days after admission to the LACJ to designate cases as “community-acquired” and 15 days after admission to designate cases as “LACJ acquired.” This range was used based on the average incubation period for a *S. aureus* skin infection plus a few days because of the potential delay in being tested at the LACJ. We realize that these designations are arbitrary and that an infection identified in the first 5 days may be a fast growing infection in a recently admitted and exposed inmate or may be due to exposure to MRSA during a previous incarceration and therefore represent LACJ acquired disease. Conversely, those infections identified more than 15 days after admission to the LACJ may be secondary to colonization acquired prior to admission to the LACJ or may be due to a slow growing infection or inmate who did not present to the medical staff upon first onset of symptoms. However, we believe that by dividing the cases into 5 and 15 days after admission, we have balanced sensitivity and specificity in our case definitions.

Several other trends are notable including the seasonal (summer) increase in infections, gender disparities, and antibiotic susceptibilities. Warm weather peaks of CAMRSA have been seen in other studies and the increased incidence of CAMRSA during this time might be due to increased skin-to-skin contact due to outdoor, physical activities with decreased skin coverage by clothes. The greater prevalence of MRSA among women entering the LACJ may be explained by women’s greater healthcare



seeking behaviors and a greater proportion of women incarcerated for drug charges than men in correctional facilities; drug use is a risk factor for CAMRSA. Finally, despite the heavy use of TMP-SMX, clindamycin, and rifampin for empiric treatment of wound infections, this jail strain of MRSA is remaining largely susceptible to these antibiotics. Furthermore, with a decrease in the use of tetracycline as a first line treatment for skin infections (as had occurred prior to 2002), MRSA is becoming more susceptible to this antibiotic.

This study is descriptive and has limitations, which might both under- and over-estimate the number of MRSA infections reported at the LACJ. At the beginning of the outbreak, many LACJ physicians did not culture wound infections so that the number of MRSA infections is probably undercounted early in the outbreak. It is certainly possible that the doubling of cases of CAMRSA from 2002 to 2003 was due to better surveillance. Evidence for this is seen in the peaks of MRSA cases in October 2002, March 2003, and March/April 2004 after DHS physicians directly emphasized to LACJ healthcare personnel the need for expanded culturing of wound infections. Overall, the number of cases recorded here are probably an undercount of the true number of cases associated with the LACJ for the following reasons: inmates may not have felt comfortable approaching security or medical personnel, medical personnel may not have cultured a lesion or the infection (like cellulitis) was not able to be cultured, only skin/soft tissue and blood infections were counted and MRSA can affect the entire body, and inmates may have been exposed to MRSA while in LACJ but not exhibit symptoms of infection until after discharge from the LACJ and those cases would not be counted. Furthermore, we were only able to identify inmates by their booking number, which is unique for each arrest (not each person). Therefore, inmates who had a case of MRSA on one admission to the LACJ and also presented with MRSA on subsequent admissions to the LACJ will be counted as two (or more) incident cases, rather than one. Depending on the recidivism rate, the number of MRSA cases might be artificially inflated. Finally, by only counting incident and not repeat cases of MRSA, we may have underestimated the burden of this disease on this population because we did not count recurrent disease which is a common manifestation of this pathogen.

Jails are short-term correctional facilities and have a high turnover. Unlike a hospital or a sports team, where the goal of complete eradication of MRSA is feasible, the goal in this situation is to mitigate the spread of MRSA in the facility. Current guidelines focus on improving diagnosis, treatment, and personal and environmental hygiene; but it is hard to maintain increased vigilance given the high turnover of inmates and the limited resources that most correctional facilities face. The control measures we recommended were not able to eradicate MRSA from LACJ for several reasons including limited financial resources and limited personnel to ensure cleaning, education, and screening. Furthermore, it is clear that as long as MRSA is prevalent in the outside community, it will be continually re-introduced in the LACJ. More research is needed into determining the greatest preventable risk factors for MRSA in these situations and the most efficacious interventions.