Community-acquired Methicillin-resistant *Staphylococcus aureus*, Uruguay

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A novel, multidrug-resistant *Staphylococcus aureus* clone (Uruguay clone) with a non–multidrug-resistant phenotype caused a large outbreak, including 7 deaths, in Montevideo, Uruguay. The clone was distinct from the highly virulent community clone represented by strain MW2, although both clones carried Panton-Valentine leukocidin gene and *cna* gene.

Since the 1990s, multidrug-resistant *Staphylococcus aureus* (MRSA) infections have been increasingly recognized in the community, and MRSA strains isolated from patients with community-associated cases have been called community-associated MRSA (CA-MRSA) (1). CA-MRSA strains have been reported to differ from isolates from hospitals (healthcare-associated MRSA; HA-MRSA) in many characteristics such as susceptibility to antimicrobial drugs, types of staphylococcal cassette chromosome (SCC) *mec* element, and repertoires of exotoxin gene. In Uruguay, MRSA strains are among the most prevalent nosocomial pathogens. In late 2001, we observed a case in a young man with recurrent boils who visited an outpatient clinic. An MRSA strain that was susceptible to other drugs was isolated from the patient. After that, pediatric infections associated with similar strains were observed (2). The initial sporadic cases were followed by an epidemic increase of infections in the community, hospitals, and jails. We began to record the microbiologic data and analyze cases together with the National Antimicrobial Resistance Surveillance Network belonging to the Public Health Ministry in Uruguay, and we concluded that a large outbreak of CA-MRSA strains occurred in Uruguay. Here we report the emergence of a novel CA-MRSA clone, which has been shown by multilocus sequence typing (MLST) and SCC*mec* type to be distinct from the midwestern CA-MRSA strain.

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The Study

We studied patients with non–multidrug-resistant MRSA infections identified at 2 hospital centers in the metropolitan area of Montevideo, Uruguay, Hospital Maciel and Centro de Asistencia del Sindicato Médico del Uruguay, from January 2002 to October 30, 2003. A total of 125 *S. aureus* strains that were resistant to oxacillin alone or to erythromycin in addition were isolated from outpatients and inpatients. Since 1 of our members noticed some cases of pyogenic infections in a prison, we conducted a sentinel study of skin and soft tissue infection (SSTI) in the 2 main prisons from May to June in 2003. We isolated 40 non–multidrug-resistant MRSA strains from 58 inmates with SSTIs. Of these 40 strains, 17 were randomly selected to be analyzed. Susceptibilities to 8 antimicrobial drugs (oxacillin, vancomycin, gentamicin, rifampin, ciprofloxacin, erythromycin, clindamycin, and trimethoprim-sulfamethoxazole) were tested by the Kirby Bauer disk diffusion test (Becton Dickinson, Cockeysville, MD, USA). Production of PBP2′ and protein A were verified by MRSA Screen latex PBP2′ (Denka Seiken-Oxoid Ltd, London, UK) and latex slide agglutination kits (Oxoid, Hampshire, UK), respectively. Most (133/142, 94%) showed heterogeneity in the degree of resistance to oxacillin, since double halos or haze zones were observed around the disk containing 1 μg of oxacillin.

The course of the outbreak during the 22 months is shown in Figure 1. The number of MRSA infections increased greatly in 2003. The Table summarizes the cases in which non–multidrug-resistant MRSA strains were isolated. Of the 125 case-patients, 112 were adults. The mean age was 39.7 years, which was lower than that of case-patients infected with HA-MRSA strains (mean age 59 years) reported previously (3). We classified the cases as community-associated if MRSA was isolated from cultures performed within 48 hours after admission to hospitals and excluded patients who had previously noted criteria for risk factors of HA-MRSA acquisition: recent hospitalization (within the last 6 months); use of medical devices (such as a permanent indwelling catheter or percutaneous medical device); exposure to healthcare services, including invasive or surgical procedures; residence in a long-term care facility; and any known antimicrobial drug use within the past year (4,5). Community-associated cases were dominant (78%). The predominant infection type in adults was skin and soft tissue infection (n = 86)

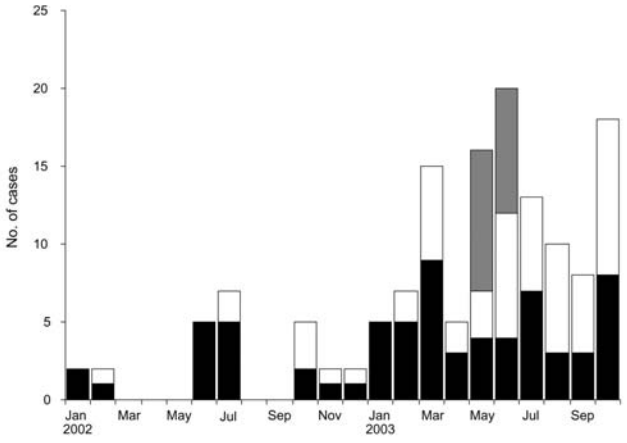

Figure 1. The monthly accumulation of cases of infections due to non–multidrug-resistant *Staphylococcus aureus* strains from January 2002 to October 2003. Black blocks indicate numbers of strains that were isolated from patients in the public hospital (Hospital Maciel), white indicates strains from a private hospital (Centro de Asistencia del Sindicato Médico del Uruguay), and gray indicates strains from 2 prisons (Libertad and Comcar).

such as abscesses, boils, and cellulitis, followed by respiratory tract infections, among which 12 of 14 were pneumonia. Four of 14 adult patients with respiratory tract infections exhibited symptoms of acute severe pneumonia, with histopathologic findings of "necrotizing pneumonia," and all died after bacteremia developed. Besides developing in these 4 patients with fatal cases, bacteremia developed in 9 other patients, and 3 of them died. The sites of infection preceding the bacteremia for these 3 patients were skin and soft tissue, bone and joint (septic arthritis), and unknown (classified as septic syndrome in Table), respectively. Bacteremia also developed in 3 pediatric patients. In total, bacteremia developed in 17 patients, and 7 died during the study period. We studied the molecular microbiologic characteristics of 68 isolates: 16 from the patients in whom bacteremia developed, 35 randomly selected from all case-patients, and 17 from the inmates.

Pulsotypes, coagulase isotypes, SCC*mec* types, and exotoxin gene repertoires were examined by the methods indicated in the footnotes of the online Appendix Table (available at http://www.cdc.gov/ncidod/eid/vol11no06/04-1059_app.htm). Among 6 pulsotypes identified in the Uruguay strains, 38 (74.5%) of 51 isolates from patients and all 17 isolates from the inmates, had related pulsotypes within 4 band differences designated A1–A4 (Appendix Table). All of them produced type-4 coagulase and carried type IVc SCC*mec* element, 53 of 55 carried *lukS,F-PV* genes, and 51 of 55 carried the *cna* gene. Isolates from 11 of 16 bacteremic case-patients, including 6 who died, belonged to pulsotype A. Evidence shows that a clone

Table. Clinical presentation of 125 MRSA-infected case-patients, Montevideo, Uruguay*

	Adult patients infected in†			Pediatric patients infected in‡	
Clinical feature	Community	Hospital	Unknown	Community	Hospital
Skin and soft tissue					
Abscess	26 (4) ¶			3 (3)	
Boils	20 (5)			1(1)	
Cellulitis	15 (3)	2 (2) ¶		2 (1)¶	
Hidradenitis	3 (2)				
Myositis	1 (1)				
Wound infection	8 (3)	11 (3)			
Infected atopic dermatitis					1 (1)¶
Respiratory tract					
Upper respiratory tract infection				4 (1)	
Necrotizing pneumonia	4 (3)¶#				
Pneumonia	1 (1)	3 (1) ¶			
Ventilator-associated pneumonia§		4(4)			
Colonization in respiratory tract		2(2)			
Catheter-associated infection					1 (1) ¶
Cerebrospinal fluid shunt					1(1)
Bone and joint infection	2 (1)¶	1 (1)¶			
"Sepsis" syndrome	5 (4) ¶		4 (2)		
Total	85 (27)	23 (13)	4 (2)	10 (6)	3 (3)

*MRSA, methicillin-resistant *Staphylococcus aureus*; parenthesis indicate the numbers of case-patients whose MRSA isolates were analyzed in this study.
†The range and mean age were 16–82 years and 39.7 years, respectively. The number of male and female case-patients were 65 (58%) and 47 (42%), respectively. Twenty-nine case-patients required hospitalization.
‡The range and mean age were 16–82 years and 6 years, respectively. The numbers of male and female case-patients were 8 and 5, respectively. One patient required hospitalization.
§Ventilator-associated pneumonia of the patients in an intensive care unit.
¶Besides 9 cases of sepsis syndrome, some of the other case categories were also bacteremic. They were 1 abscess, 4 necrotizing pneumonia, 2 bone and joint, 2 cellulitis, 1 infected atopic dermatitis, and 1 catheter-associated infection.
#A strain isolated from 1 of the patients was lost for analysis in this study.

(pulsotype A-SCC*mec* IVc), which possessed both *cna* and *lukS,F-PV* genes, caused the outbreak in Uruguay.

Other pulsotype strains carried primarily other SCC*mec* elements, such as type-II, type-IVa, or type-V, and produced type-2, -5, or -7 coagulase and did not carry *lukS,F-PV* genes. Notably, 49 (96%) of 51 strains isolated from both community-associated and healthcare-associated cases carried either type-IV or type-V SCC*mec* element, which have been found in CA-MRSA strains (6–8).

We compared characteristics of outbreak strains with those of previously investigated CA-MRSA strains isolated in the United States (MW2) and Australia (A803355, A823549, and E802537), and a strain isolated from an outpatient in Japan in 1981 (81/108) (Figure 2). All of them possessed both *cna* and *lukS,F-PV* genes as well. The dominant outbreak strains belonged to ST-30, which was the same as Australian and Japanese strains and distinct from MW2 (ST-1). In addition, we found that the pulsotype of strain A803355 (reported previously as H1) was identical to pulsotype A1, the most representative pulsotype among tested strains. Pulsotypes of other 2 Australian strains, A823549 and E8025347, were classified into the same cluster as A, while that of 81/108 showed a similar type on pulsed-field gel electrophoresis (PFGE) to pulsotype A. In contrast, only 2 Uruguay isolates, UR20 and UR41, had a PFGE pattern similar to that of MW2.

Conclusions

The outbreak of CA-MRSA in Uruguay involved >1,000 patients and ≥12 deaths, when the data after this study period are added. According to a follow-up survey conducted at jails from May to October 2003, 890 of 1,142 inmates were infected with similar pyogenic infections after an outbreak of scabies (10). Five patients required hospitalization. Boils and abscesses in the buttocks and neck were the most prevalent infections (85%), followed by hidradenitis and cellulitis. The prevalence of a new clone represented by UR6 (Uruguay clones) is considered to have been the cause of this large outbreak. We are conducting a further study of isolates from patients after this study period and isolates from inmates in a follow-up survey, and a final conclusion awaits those results.

We have suggested 2 genes as important candidates for high virulence in the midwestern CA-MRSA strains represented by strain MW2 (11), which is distributed in the United States and Europe (12,13). Since the Uruguay clone shared *lukS,F-PV* genes and *cna* gene with the midwestern CA-MRSA clone, this study strengthened the likelihood that these 2 genes are contributors for high virulence. Their genotypes, however, were completely different, and we now appear to have 2 distinct clones of highly virulent CA-MRSA. That certain CA-MRSA strains, identified in Australia as carrying the *luk-PV* and *cna* genes, had an identical PFGE pattern with UR6 does not imply that the same CA-MRSA clone has been disseminated between Uruguay and Australia because these 2 clones had distinct SCC*mec* elements, IVc and IVa, respectively. Since the MRSA clone originated when the SCC*mec* was integrated into the chromosome of a *S. aureus* strain, the 2 MRSA clones are understood to have originated independently by acquiring different SCC*mec* genes in their respective countries (14,15). In this regard, the difference in the SCC*mec* type was not reflected in the PFGE pattern. This example provides an excellent illustration of the fact that clonality cannot be judged on PFGE pattern alone.

Nonetheless, CA-MRSA strains with identical PFGE and MLST patterns possessing *lukS,F-PV* genes and *cna* genes exist in both Uruguay and Australia. This finding may indicate the existence of a genetically stable, virulent, multidrug-susceptible *S. aureus* (MSSA) clone in a community that extends beyond country borders and across the ocean. The MSSA clone, which has *lukS,F-PV* and *cna* genes, is established in the community and occasionally acquires SCC*mec* when the use of β-lactam antimicrobial drugs is increased to a stressful level for the survival of the MSSA clone in the community. Since we have also found MRSA strains isolated in the 1980s in Japan with a similar

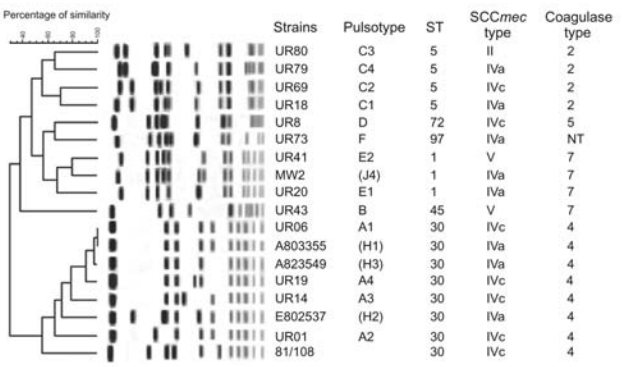

Figure 2. Dendrogram of pulsed-field gel electrophoresis (PFGE) banding pattern of representative Uruguay clone. Pulsotypes of representative Uruguay strains, a CA-MRSA strain isolated in the United States (MW2), 3 CA-MRSA strains isolated in Australia (A803355, A823549, and E802537), and a Japanese strain isolated from an outpatient (81/108) were compared by using a BioNumerics software program (Applied Maths, Sint-Martens-Latem, Belgium). Similarity coefficient was calculated by using Pearson correlation with position tolerance of 5%, and cluster analysis was performed by the unweighted pair-group method. Pulsotypes in parentheses indicate the types previously reported (7). PFGE was performed for 22 h with a CHEF MAPPER (Bio-Rad, Hercules, CA, USA) with a pulse time of 5 s to 40 s. *Sma*I-restriction patterns of the tested strains and reference strains were compared by using BioNumerics software. Genotypes of representative strains were determined by multilocus sequence typing as described by Enright et al. (9). Sequence type (ST) and clonal complex were assigned using programs in the *S. aureus* multilocus sequence typing database (http://www.mlst.net).

genotype to that of UR6 and possessing *PVL* and *cna* genes, the outbreak observed in Uruguay could occur in any part of the world if social or medical predisposing conditions are met.

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References

1. Eady EA, Cove JH. Staphylococcal resistance revisited: community-acquired methicillin resistant *Staphylococcus aureus*—an emerging problem for the management of skin and soft tissue infections. Curr Opin Infect Dis. 2003;16:103–24.
2. Galiana, VA. Infecciones por *Staphylococcus aureus* adquiridos en la comunidad. Arch Pediatr Urug. 2003;74: 26–9.
3. Annual report: National Committee of Hospital Infection Control. Montevideo, Uruguay: Ministry of Public Health; 2001.
4. Gorak EJ, Yamada SM, Brown JD. Community-acquired methicillin-resistant *Staphylococcus aureus* in hospitalized adults and children without known risk factors. Clin Infect Dis. 1999;29:797–800.
5. Shopsin B, Mathema B, Martinez J, Ha E, Campo ML, Fierman A, et al. Prevalence of methicillin-resistant and methicillin-susceptible *Staphylococcus aureus* in the community. J Infect Dis. 2000;182:359–62.
6. Ma XX, Ito T, Tiensasitorn C, Jamklang M, Chongtrakool P, Boyle-Vavra S, et al. Novel type of staphylococcal cassette chromosome *mec* identified in community-acquired methicillin-resistant *Staphylococcus aureus* strains. Antimicrob Agents Chemother. 2002;46:1147–52.
7. Okuma K, Iwakawa K, Turnidge JD, Grubb WB, Bell JM, O'Brien FG, et al. Dissemination of new methicillin-resistant *Staphylococcus aureus* clones in the community. J Clin Microbiol. 2002;40:4289–94.
8. Ito T, Ma XX, Takeuchi F, Okuma K, Yuzawa H, Hiramatsu K. Novel type V staphylococcal cassette chromosome *mec* driven by a novel cassette chromosome recombinase, *ccrC*. Antimicrob Agents Chemother. 2004;48:2637–51.
9. Enright MC, Day NP, Davies CE, Peacock SJ, Spratt BG. Multilocus sequence typing for characterization of methicillin-resistant and methicillin-susceptible clones of *Staphylococcus aureus*. J Clin Microbiol. 2000;38:1008–15.
10. Mowszowicz M, Pedreira W, Galiana A, Hiramatsu K, Ma XX, Ito T, et al. Efficacy of co-trimoxazole–high dosage short course (SXT-HDSC) in community-acquired methicillin-resistant *Staphylococcus aureus* (CA-MRSA) outbreak in Uruguay jails 2003. Int J Infect Dis. 2004;8(Suppl 1):185.
11. 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;359:1819–27.
12. Gillet Y, Issartel B, Vanhems P, Fournet JC, Lina G, Bes M, et al. Association between *Staphylococcus aureus* strains carrying gene for Panton-Valentine leukocidin and highly lethal necrotising pneumonia in young immunocompetent patients. Lancet. 2002;359:753–9.
13. Diep BA, Sensabaugh GF, Somboona NS, Carleton HA, Perdreau-Remington F. Widespread skin and soft-tissue infections due to two methicillin-resistant *Staphylococcus aureus* strains harboring the genes for Panton-Valentine leucocidin. J Clin Microbiol. 2004;42:2080–84.
14. Hiramatsu K, Cui L, Kuroda M, Ito T. The emergence and evolution of methicillin-resistant *Staphylococcus aureus*. Trends Microbiol. 2001;9:486–93.
15. Ito T, Okuma K, Ma XX, Yuzawa H, Hiramatsu K. Insights on antibiotic resistance of *Staphylococcus aureus* from its whole genome: genomic island SCC. Drug Resist Update. 2003;6:41–52.

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Correction: Vol. 11, No. 5

In "Adenovirus Type 7 Peptide Diversity during Outbreak, Korea, 1995–2000," by Eun Hwa Choi et al., errors occurred. In Table 2, column 3, amino acid sequences should be identified at position 197.

Also, Figures 1 and 2 in this article do not show all information. The online figures correctly represent the findings.

The corrected article appears online at http://www.cdc.gov/ncidod/EID/vol11no05/04-1211.htm

Correction: Vol. 11, No. 5

In "Osler and the Infected Letter," by Charles T. Ambrose, an error occurred. Yellow fever swept through Philadelphia in 1793.

The corrected article appears online at http://www.cdc.gov/ncidod/EID/vol11no05/04-0616.htm

Correction: Vol. 11, No. 5

In "Probable Tiger-to-Tiger Transmission of Avian Influenza H5N1," by Roongroje Thanawongnuwech et al., an error occurred. The GenBank accession nos. for HA and NA gene initiated from influenza A virus (A/Tiger/ Thailand/CU-T3/04) are AY842935 and AY842936.

The corrected article appears online at http://www.cdc.gov/ncidod/EID/vol11no05/05-0007.htm

We regret any confusion these errors may have caused.

Community-acquired Methicillin-resistant *Staphylococcus aureus* among Military Recruits

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We report an outbreak of 235 community-acquired methicillin-resistant *Staphylococcus aureus* (MRSA) infections among military recruits. In this unique environment, the close contact between recruits and the physical demands of training may have contributed to the spread of MRSA. Control measures included improved hygiene and aggressive clinical treatment.

Methicillin-resistant *Staphylococcus aureus* (MRSA) was first recognized in the 1960s and has since become a well-known cause of nosocomial infections (1). Recently, MRSA has been reported with increasing frequency outside healthcare settings (2–5). Community-acquired outbreaks have been reported in a variety of populations, including prison inmates (3,4), players of contact sports (6,7), children in daycare (8), and crewmembers of a naval ship (9). These groups do not possess the risk factors traditionally associated with MRSA infection, namely, recent hospitalization, dialysis, residence in a long-term care facility, or intravenous drug use (1,2). We report an outbreak of community-acquired MRSA infections among recruits at a large military training facility in the southeastern United States.

The Study

The training facility where the outbreak occurred had a recruit population that fluctuated from 3,500 to 7,000. A case-patient was defined as a recruit with a clinically recognized skin or soft-tissue infection and a positive MRSA culture from the site of infection. Laboratory records showed that from October 2000 to July 2002, 47 culture-confirmed MRSA infections occurred among recruits (Figure 1). During this period, the monthly incidence of MRSA did not exceed two cases per 1,000 recruits (Figure 2). However, from August to December 2002, 235 MRSA cases occurred. During the outbreak period, the monthly incidence rates ranged from 4.9 to 11 cases per 1,000 recruits.

Of the case-patients, 209 (89%) were men. This percentage paralleled the overall male recruit population in 2002 (88% male). Although information on the specific age of infected recruits was not available, all recruits at this facility were 17–25 years of age. Most infections occurred on an extremity (73.7%), most commonly the lower leg (16.0%) and the knee (13.9%) (Table).

To investigate what aspects of training might be associated with transmission, cases were sorted by week of training when illness was diagnosed (Figure 3). Data on training week was available for 143 (61%) of the outbreak patients. The rise in cases during weeks 1–5 suggests that transmission increased with time in training. Of the cases, 86% occurred during weeks 6 to 12 but did not seem to be associated with any single event. Moderate increases occurred during weeks 6 and 7 (rifle range training) and week 11, which included the "crucible," a 54-hour strenuous field exercise and final test before graduation. These weeks include important milestones for recruits, and some may have delayed seeking medical care until after completing these steps.

Medical records from 20 patients were randomly selected and reviewed during the investigation. These patients included 18 men and 2 women, 17–24 years of age. The diagnoses included abscesses (15 patients), cellulitis (2 patients), and folliculitis (3 patients). The antimicrobial agents most commonly prescribed for initial treatment were dicloxacillin (6), levofloxacin (5), and

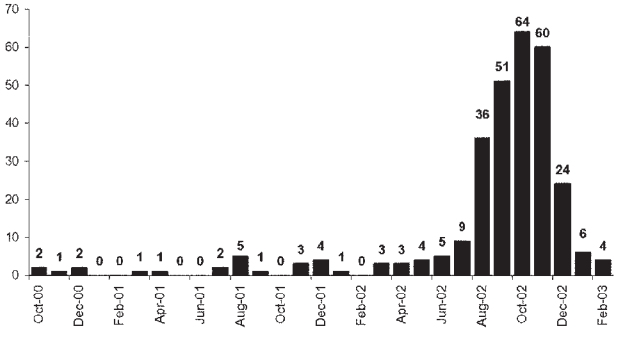

Figure 1. Methicilin-resistant *Staphylococcus aureus* cases in recruits.

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[1]Views expressed are those of the authors and are not approved by or representative of the Bureau of Medicine and Surgery, the Department of the Navy, or the Department of Defense.

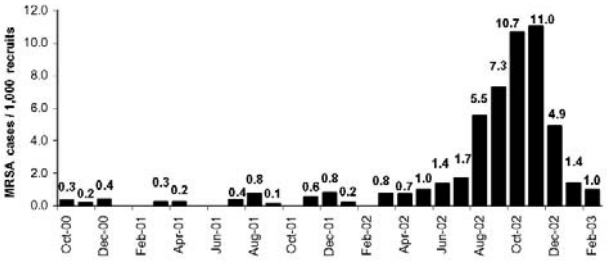

Figure 2. Methicilin-resistant *Staphylococcus aureus* (MRSA) incidence.

ciprofloxacin (4). No patients had a history of hospitalization within the previous year, although one patient had been treated with levofloxacin for pneumonia 2 weeks before.

Nasal screening was conducted to identify carriers and determine the colonization rate among staff members permanently assigned to the training facility. Anterior nasal swabs were obtained from 874 workers who had direct contact with recruits, including medical, dental, and laboratory personnel, drill instructors, barbers, and other ancillary staff. Of these, 24 (2.7%) were colonized with MRSA.

Through interviews with healthcare providers, laboratory personnel, and recruits, investigators found that most patients did not display established risk factors for MRSA (history of chronic medical conditions, hospitalization or surgery within the previous year, history of drug use, or recent use of an antimicrobial agent). Also, the MRSA isolates were sensitive to many commonly used outpatient antimicrobial agents, including trimethoprim/sulfamethoxazole and clindamycin.

No recent lapses in recruit hygiene training or practices had occurred. Recruits were afforded daily time for showering, cleaning, and personal hygiene. However, this time was limited, perhaps leading to deficient hygiene practices among some recruits (i.e., inadequate showering, infrequent handwashing, sharing towels and other personal items).

In November 2002, facility personnel implemented an array of control measures with an emphasis on improving hygiene and treatment regimens. Based on existing recommendations for preventing MRSA transmission in healthcare settings (10), antibacterial soaps and hand sanitizers were placed at all recruit sinks, and investigators recommended that hand washing be conducted as frequently as possible. All recruits were issued personal bottles of antibacterial hand sanitizer for use when soap and water were not readily available. Daily showers of adequate duration were enforced, and sharing personal items such as towels and razors was prohibited.

In addition, local healthcare providers were alerted to the presence of MRSA among recruits. Culturing of lesions was encouraged. Patients were treated with the following regimen aimed at eliminating both MRSA infection and nasal carriage: oral rifampin and minocycline for 10 to 14 days, nasal mupirocin twice daily for 10 days, and Hibiclens washes. (Trimethoprim/sulfamethoxazole could be substituted for minocycline.) Finally, preventive medicine staff conducted biweekly surveillance for MRSA cases by using laboratory records.

Table. Anatomic site of MRSA infection

Site[b]	No. patients	(%)
Lower extremity	86	(44.3)
Thigh/hip	15	(7.7)
Knee	27	(13.9)
Leg	31	(16.0)
Ankle	2	(1.0)
Foot	11	(5.7)
Upper extremity	57	(29.4)
Axilla	8	(4.1)
Arm	20	(10.3)
Elbow	13	(6.7)
Forearm	7	(3.6)
Hand	9	4.6
Head	4	(2.1)
Face	4	(2.1)
Neck	3	(1.5)
Torso	3	(1.5)
Back	9	(4.6)
Buttocks	12	(6.2)
Inguinal	1	(0.5)
Genital	4	(2.1)
Urine	1	(0.5)
Sputum	1	(0.5)
Tissue, unspecified	9	(4.6)

[a]MRSA, methicillin-resistant *Staphylococcus aureus*.
[b]Site unknown for 41 patients.

The outbreak ended in December 2002, shortly after interventions were implemented. The actual number of cases as well as the incidence (cases per 1,000 recruits) declined by more than half in December 2002 and decreased further in January and February 2003 (Figures 1 and 2).

Conclusions

This large outbreak demonstrates the threat of MRSA in a close-contact environment such as recruit training. Our findings are consistent with community-acquired, rather than nosocomial, MRSA infection (1–3,6). MRSA is spread by direct contact, most often through the hands of an infected or nasally colonized person (3). Several recent community-acquired MRSA outbreaks have involved comparable close-contact environments (3,8,9). Spread of community-acquired MRSA has also been associated with prolonged physical contact between sports participants (6,7). Activities such as hand-to-hand combat training, life-saving, and team skill-building exercises involve similar physical contact between recruits.

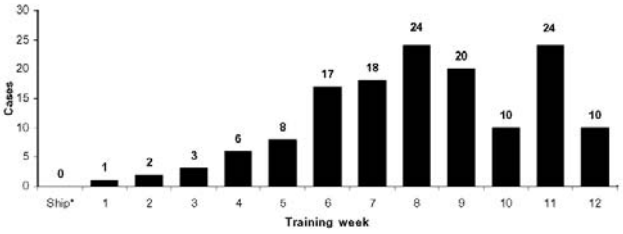

Figure 3. Methicilin-resistant *Staphylococcus aureus* cases by week of training. *Recruits arrive at the facility during ship week and undergo medical and administrative in-processing.

The physical nature of recruit training is another factor that may have contributed to this outbreak. Recruits often have minor cuts or abrasions that increase the risk of developing skin infections. Such injuries would be expected during physically demanding activities such as running, hiking, and negotiating obstacle courses. Indeed, most MRSA infections occurred on exposed surfaces such as arms, legs, and knees.

The growth and transmission of methicillin-sensitive *S. aureus* (MSSA), and accordingly MRSA, are increased in humid environments (11). The number of cases increased during warmer months, a time when recruits have more exposed skin surfaces. This may increase their risk for superficial wounds as well as contact with other recruit's skin surfaces. Furthermore, some recruits reported that their infections started as insect bites, also a seasonal problem.

The outbreak was unlikely to have originated from a single source. Cases occurred throughout the facility and were not localized to recruits who had contact with a particular instructor or other staff member. Further, the percentage of staff members at the facility who were found to be carriers was small and consistent with the 2%–3% MRSA carriage rates found in recent studies (9,12,13). Although how much contact these carriers routinely had with recruits is unclear, this small number of patients was not likely a major factor in spreading MRSA across so many different groups of recruits. In fact, the growing prevalence of MRSA in the general population (1,2,12,14) is an important concern because recruits may enter the military already colonized.

Maintaining good hygiene and avoiding contact with open skin lesions are the primary means to prevent the spread of MRSA infections (3,7). Although no recent changes in recruit hygiene had occurred that were directly responsible for the outbreak, the hygiene deficiencies noted in some recruits combined with the increased prevalence of MRSA were important contributing factors. Control measures were instituted to improve hygiene, including frequent hand washing and the use of antibacterial hand sanitizers. Similar measures have been implemented to control MRSA outbreaks in comparable settings (3,6,7,15).

Before August 2002, healthcare providers did not routinely obtain bacterial identification and sensitivities on skin infections, possibly delaying effective treatment in some cases. Once aware that MRSA was prevalent among recruits, healthcare providers improved treatment by culturing skin lesions whenever possible and prescribing appropriate antimicrobial agents for MRSA infections. Thus, the primary interventions used were recommending improved hygiene practices for recruits and implementing aggressive clinical protocols. These control measures, along with the onset of cooler weather, likely played important roles in ending the outbreak.

This outbreak occurred in a previously healthy military training population and was associated with close contact, limited opportunity for practicing good personal hygiene, warm weather, and physical stress. Reducing MRSA infections was related to implementing interventions to improve personal hygiene, aggressive evaluation and treatment of people with soft tissue injuries and infections, and cooler weather.

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References

1. Chambers H. The changing epidemiology of *Staphylococcus aureus*? Emerg Infect Dis 2001;7:178–82.
2. Naimi T, LeDell K, Boxrud D, Groom A, Steward C, Johnson S, et al. Epidemiology and clonality of community-acquired methicillin-resistant *Staphylococcus aureus* in Minnesota, 1996-1998. Clin Infect Dis 2001;33:990–6.
3. Centers for Disease Control and Prevention. Methicillin-resistant *Staphylococcus aureus* skin or soft tissue infections in a state prison—Mississippi, 2000. MMWR Morb Mortal Wkly Rep 2001;50:919–22.
4. Pan E, Diep B, Carleton H, Charlebois E, Sensebaugh G, Haller B, et al. Increasing prevalence of methicillin-resistant *Staphylococcus aureus* infection in California jails. Clin Infect Dis 2003;37:1384–8.
5. Baggett H, Hennessy T, Leman R, Hamlin C, Bruden D, Reasonover A, et al. An outbreak of community-onset methicillin-resistant *Staphylococcus aureus* skin infections in southwestern Alaska. Infect Control Hosp Epidemiol 2003;24:397–402.
6. Lindenmayer J, Schoenfeld S, O'Grady R, Carney J. Methicillin-resistant *Staphylococcus aureus* in a high school wrestling team and the surrounding community. Arch Intern Med 1998;158:895–9.

7. Centers for Disease Control and Prevention. Methicillin-resistant *Staphylococcus aureus* infections among competitive sports participants—Colorado, Indiana, Pennsylvania, and Los Angeles County, 2000–2003. MMWR Morb Mortal Wkly Rep 2003;52:793–5.
8. Adcock P, Pastor P, Medley F, Patterson J, Murphy T. Methicillin-resistant *Staphylococcus aureus* in two childcare centers. J Infect Dis 1998;178:577–80.
9. Lamar J, Carr R, Zinderman C, McDonald K. Sentinel cases of community-acquired methicillin-resistant *Staphylococcus aureus* onboard a Naval Ship. Mil Med 2003;168:135–8.
10. Centers for Disease Control and Prevention. Guideline for hand hygiene in healthcare settings: recommendations of the healthcare infection control practices advisory committee and the HICPAC/SHEA/APIC/IDSA hand hygiene task force. MMWR Recomm Rep 2002;51:1–56.
11. Chin J, editor. Control of communicable diseases manual. 17th ed. Baltimore: United Book Press, Inc.; 2000.
12. Kenner J, O'Connor T, Piantanida N, Fishbain J, Eberly B, Viscount H, et al. Rates of carriage of methicillin-resistant and methicillin-susceptible *Staphylococcus aureus* in an outpatient population. Infect Control Hosp Epidemiol 2003;24:439–44.
13. Jernigan J, Pullen A, Partin C, Jarvis W. Prevalence and risk factors for colonization with methicillin-resistant *Staphylococcus aureus* in an outpatient clinic population. Infect Control Hosp Epidemiol 2003;24:445–50.
14. Kallen A, Driscoll T, Thornton S, Olson P, Wallace M. Increase in community-acquired methicillin-resistant *Staphylococcus aureus* at a naval medical center. Infect Control Hosp Epidemiol 2000;21:223–6.
15. Bureau of Prisons. Clinical practice guidelines for the management of methicillin-resistant *Staphylococcus aureus* infections [accessed 2003 Nov 1]. Available from: http://nicic.org/Downloads/PDF/2003/019356.pdf

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Community-Associated Methicillin-Resistant *Staphylococcus aureus* Infections in Pacific Islanders --- Hawaii, 2001--2003

Methicillin-resistant *Staphylococcus aureus* (MRSA) is emerging as a cause of skin and soft-tissue infections in persons who have little or no contact with health-care settings. The majority of these infections are mild, involving skin and soft tissue; however, certain cases can progress to invasive tissue infections, bacteremia, and death (*1*). Transmission of MRSA has been reported most frequently in certain populations (e.g., children, sports participants, or jail inmates) (*2*,*3*). Persons in the American Indian or Alaska Native population in the United States and aboriginals and Pacific Islanders (PIs) in Australia have high rates of MRSA colonization and infection (*4*,*5*). In 2003, clinicians reported an increased number of skin abscesses caused by MRSA among patients examined in ambulatory care settings. This report summarizes the findings of a retrospective study of community-associated MRSA (CA-MRSA) infections in Hawaii that identified a higher proportion of cases among PIs than were identified among Asians, compared with their respective proportions in the Hawaii population. Efforts to prevent CA-MRSA in Hawaii should focus on identifying factors causing the disproportionate number of infections among PIs.

Four health-care facilities in Hawaii were selected for the study: a pediatric and women's center, a private urban clinic, a county urban hospital, and a rural community hospital. Patients with MRSA isolated during the study period were identified, and chart abstraction was performed for those patients who had illness consistent with the CA-MRSA case definition*. Chart information on race was self-reported. Race categories included white, black, Asian, multiracial non-PI, and PI (i.e., Native Hawaiians and persons of Polynesian, Micronesian, and Melanesian ancestry). The category PI also was used for persons who were PI in addition to another race. Data from the 2001 Hawaii Health Survey, Hawaii State Department of Health (*6*), and 2002 hospital data from the pediatric and women's center were used for population comparisons.

During July 2001--June 2003, MRSA was recovered from 1,389 patients in the four study facilities, of whom 389 (28%) had illness consistent with the case definition for CA-MRSA infection; 346 (89%) of these patients had racial/ethnic data recorded on their charts. PIs accounted for 51% (178 of 346) of the CA-MRSA patients, compared with 24% (278,607 of 1,175,595) of the total population of Hawaii in 2001 ($p<0.01$) (*6*). In the pediatric and women's center alone, PIs accounted for 76% (90 of 118) of CA-MRSA patients, compared with 35% (17,088 of 48,912) of the patients served in this facility in 2002 ($p<0.01$). In contrast, Asians accounted for 16% (54 of 346) of all patients with CA-MRSA, compared with 32% (374,776 of 1,175,595) of the 2001 Hawaii population ($p<0.01$). In the pediatric and women's center alone, Asians constituted 10% (12 of 118) of CA-MRSA patients, compared with 36% (17,648 of 48,912) of the patients examined in 2002 ($p<0.01$). Among all CA-MRSA patients, 211 (61%) were male; median age was 18.5 years (range: 0--87 years) for PIs and 32 years (range: 0--93 years) for other races ($p<0.01$). Of 321 patients who received antimicrobial therapy, 215 (67%) were treated with an antimicrobial agent to which *S. aureus* was resistant. Adult PIs (i.e., aged $\geq$19 years) had diabetes mellitus more often than adults of other races (27% versus 12%; $p<0.05$) and reported intravenous drug use less often (1% versus 8%; $p<0.05$).

Among patients with CA-MRSA, adult PIs had skin and soft tissue infections more often than adults of other races (98% [87 of 89] versus 85% [119 of 140]; $p<0.05$). The majority of skin infections in PIs consisted of abscesses (71% [126 of 178]) and/or cellulitis (41% [73 of 178]). Other skin infections were wounds/ulcers (six), impetigo (four), and folliculitis (three). Of the PIs with skin infections, 11 had concurrent illnesses (e.g., deep soft-tissue infections, bacteremia, bursitis, osteomyelitis, and pneumonia). Among the 28 patients who did not have skin infections, pneumonia was the most frequent presentation

(five PIs and seven others).

Despite differences in clinical presentation, the proportion of patients hospitalized and the types of therapies received were similar for PIs and patients of other races when stratified by age group. The majority of patients received antimicrobials to treat MRSA infection (98% [174 of 177] among PIs and 96% [156 of 163] among other races). Among adults, surgery, mostly incision and drainage of abscesses, was performed on 62% (54 of 87) of PIs and 57% (73 of 129) of patients of other races. Among persons aged <19 years, surgery was performed on 64% (56 of 88) of PIs and 72% (18 of 25) of patients of other races.

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Editorial Note:

In 2000, PIs, alone or in combination with other races, made up only 0.3% (874,000) of the total U.S. population. However, in Hawaii, the state with the largest PI population, 23% of the population was PI in 2001 and 32% was Asian (*6*). Historically, PIs have been grouped with persons of Asian origin for demographic purposes; however, these two populations might differ in health status and risk factors for infectious and noninfectious diseases. This report documents that the number of CA-MRSA infections in Hawaii is disproportionately greater among PIs than among Asians. Clinical presentation as skin and soft-tissue infection also was more frequent among PIs than among patients of other races.

Several factors might contribute to higher rates of CA-MRSA among PIs. In Australia, Hawaii, and New Zealand, PIs have higher reported rates of infections by *S. aureus*, group A streptococcus, and *Neisseria meningitidis* than persons of other races (*5*,*7*). Geographic isolation might have facilitated transmission of genetic traits conferring differences in immune function; however, little has been reported on specific immunologic differences among PIs (*5*,*7*). Alternatively, environmental factors such as home overcrowding, inadequate access to appropriate sanitation, and limited access to health care also might contribute to a higher rate of bacterial infections, especially skin infections (*2*,*3*,*7*). Because of the limited information recorded in medical charts, presence of these risk factors could not be assessed in this study. However, in the 1990 Census, persons who self-identified as PIs had larger families, a lower proportion of college graduates, and higher poverty rates, compared with persons who self-identified as Asian/PIs and the overall national average (*8*). Cultural and language barriers, limited access to health care, and lack of prevention and education programs also are known to contribute to poorer health among PIs (*9*).

In this study, investigators also observed a higher proportion of diabetes mellitus among PIs with CA-MRSA infections. Persons with diabetes and obesity are at risk for skin and soft-tissue infections, which can require multiple and/or prolonged courses of antibiotics, making them more susceptible to infections with antimicrobial-resistant strains (*10*).

The findings in this report are subject to at least one limitation. The PIs identified as CA-MRSA patients from the four facilities in this study might not be representative of the total PI population in Hawaii in terms of health-risk factors. This might have widened the disparity between the percentage of CA-MRSA cases accounted for by PIs and the percentage of PIs in the general state population. However, PI patients at the pediatric women's center also were compared with the center's patient census. This comparison revealed similar disproportionate prevalence of CA-MRSA infections in PIs, compared with Asians and the total patient census.

Prospective studies are needed to identify specific risk factors for, and targeting measures to prevent, MRSA acquisition and transmission among PIs. General strategies to prevent and control CA-MRSA infections include 1) encouraging clinicians to culture suspect lesions and provide targeted antimicrobial and surgical therapy, 2) maintaining appropriate infection-control precautions during wound care of

patients with skin infections at outpatient health-care facilities, and 3) providing patients and families with simple instructions to prevent transmission of skin infections to family members and other contacts, such as education on appropriate wound management, hand and body hygiene, and limiting sharing of potentially contaminated items. Additional information about CA-MRSA is available at http://www.cdc.gov/ncidod/hip/aresist/mrsa_comm_faq.htm.

References

1. CDC. Four pediatric deaths from community-acquired methicillin-resistant *Staphylococcus aureus*---Minnesota and North Dakota, 1997--1999. MMWR 1999;48:707--10.
2. CDC. Methicillin-resistant *Staphylococcus aureus* infections in correctional facilities---Georgia, California, and Texas, 2001--2003. MMWR 2003;52:992--6.
3. CDC. Methicillin-resistant *Staphylococcus aureus* infections among competitive sports participants---Colorado, Indiana, Pennsylvania, and Los Angeles County, 2000--2003. MMWR 2003;52:793--5.
4. Baggett HC, Hennessy TW, Leman R, et al. An outbreak of community-onset methicillin-resistant *Staphylococcus aureus* skin infections in southwestern Alaska. Infect Control Hosp Epidemiol 2003;24:397--402.
5. Hill PC, Birch M, Chambers S, et al. Prospective study of 424 cases of *Staphylococcus aureus* bacteraemia: determination of factors affecting incidence and mortality. Intern Med J 2001;31:97--103.
6. 2001 State of Hawaii Data Book. Table 1.33. Ethnic stock by counties: 2001. Available at http://www.state.hi.us/dbedt/db01/01/013301.pdf.
7. Crump JA, Murdoch DR, Baker MG. Emerging infectious diseases in an island ecosystem: the New Zealand perspective. Emerg Infect Dis 2001;7:767--72.
8. U.S. Bureau of the Census. We the Americans: Pacific Islanders. Washington, DC: U.S. Bureau of the Census, 1993. Available at http://www.census.gov/apsd/wepeople/we-4.pdf.
9. The Health Care Challenge: Acknowledging Disparity, Confronting Discrimination, and Ensuring Equality. Washington, DC: U.S. Commission on Civil Rights, 1999.
10. Garcia-Hidalgo L. Dermatological complications of obesity. Am J Clin Dermatol 2002;3:497--506.

* A case of CA-MRSA was defined as illness compatible with staphylococcal disease, in which MRSA was cultured from the site of infection during July 2001--June 2003 in an outpatient setting or <48 hours after hospital admission, and with none of the following health-care risk factors: hospitalization, surgery, dialysis, or residence in a long-term--care facility <1 year before the onset of illness; permanent indwelling catheter or percutaneous medical device; or a previous positive MRSA culture.

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INTERNATIONAL NOTES

PUBLIC HEALTH DISPATCH: OUTBREAKS OF COMMUNITY-ASSOCIATED METHICILLIN-RESISTANT *STAPHYLOCOCCUS AUREUS* SKIN INFECTIONS - LOS ANGELES COUNTY, CALIFORNIA, 2002-2003

During 2002, the Los Angeles County Department of Health Services (LACDHS) investigated three community outbreaks of skin infections associated with methicillin-resistant *Staphylococcus aureus* (MRSA). MRSA commonly has occurred in health-care settings; however, recent investigations of community-associated MRSA (CA-MRSA) have identified infection in various settings, including correctional facilities, athletic teams, and others (CDC, unpublished data, 2002). This report describes investigations of CA-MRSA in Los Angeles County.

In September 2002, LACDHS investigated cases of MRSA infection in two athletes on the same team who were hospitalized with MRSA within the same week. No additional cases of MRSA have been identified. The source of MRSA infection for these patients has not been determined.

On November 22, 2002, physicians from two large infectious disease clinical practices notified LACDHS of MRSA skin infections among men who have sex with men (MSM). LACDHS has increased surveillance in selected clinics serving MSM and has begun a study of risk factors for infection among this population.

Currently, LACDHS is investigating an outbreak in the Los Angeles County Jail, in which 928 inmates had MRSA wound infections diagnosed in 2002. Patients were reported as having spider bites but subsequently were found to be infected with MRSA. Review of medical charts of 39 of the 66 inmates hospitalized with these infections indicated that all initially had skin infections, but 10 later had invasive disease, including bacteremia, endocarditis, or osteomyelitis. The Los Angeles County Jail is the largest jail system in the United States; 165,000 persons are incarcerated in the jail each year. LACDHS issued recommendations for the diagnosis and treatment of skin infections in the jail and is working with the Los Angeles County Sheriff's Department to review policies and procedures on laundry, showers, environmental cleaning, skin care, and control of person-to-person transmission.

In each of these outbreaks, antimicrobial susceptibility patterns from MRSA isolates of these patients have been similar, including resistance to fluoroquinolones. Molecular analysis by pulsed-field gel electrophoresis (PFGE) of isolates performed at the Los Angeles County Public Health Laboratory has identified a predominant strain common to all of these outbreaks. The PFGE pattern of the predominant strain also is consistent with PFGE patterns that CDC has identified in community outbreaks from other parts of the United States (CDC, unpublished data, 2003). Selected MRSA isolates will be sent to CDC to characterize their virulence factors and toxins.

LACDHS is advising health-care providers to be aware that MRSA is a documented cause of community-associated skin and soft tissue infections. Local treatment and incision and drainage remain first-line therapies for soft tissue infections. Clinicians who suspect MRSA skin and soft tissue infections should consider microbiologic culture of wounds and appropriate antimicrobial therapy.

Skin infections might be prevented by keeping cuts and abrasions clean by washing with soap and water. Previous investigations of MRSA infection clusters in community settings have identified MRSA transmission through sharing common objects (e.g., athletic equipment, towels, benches, and personal items) contaminated with MRSA (CDC, unpublished data, 2002). To prevent MRSA infections from spreading in health-care settings, health-care providers should use standard precautions and appropriate hand hygiene between treating patients, clean surfaces of examination rooms with commercial disinfectant or diluted bleach (1 tablespoon bleach in 1 quart water), and carefully dispose of dressings and other materials that come into contact with pus, nasal discharge, blood, and urine(1).

The outbreaks described in this report reflect the importance of CA-MRSA infections. In collaboration with state health departments, CDC is conducting active, population-based surveillance for CA-MRSA in selected regions of the UnitedUnited States to help characterize the incidence and risk factors for MRSA in the community.

Reference

1. CDC. *Guideline for hand hygiene in health-care settings: recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force*. MMWR 2002;51(No. RR-16).

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Methicillin-Resistant *Staphylococcus aureus* Infections in Correctional Facilities --- Georgia, California, and Texas, 2001--2003

Infections caused by methicillin-resistant *Staphylococcus aureus* (MRSA) (Figure) are common in hospitals and nursing homes. Because MRSA is resistant to all commonly prescribed beta-lactam antibiotics (e.g., penicillins and cephalosporins), these infections require treatment with alternative antimicrobial drugs. In addition, because antimicrobial drugs usually must be selected before identifying MRSA as the cause of infection, treatment presents a challenge for clinicians. MRSA has emerged recently as a more frequent cause of skin and soft tissue infections in the community, particularly in correctional facilities such as prisons, jails, and detention centers (*1*--*3*). This report summarizes recent investigations of MRSA transmission among inmates of correctional facilities in Georgia, California, and Texas. Inadequate personal hygiene, barriers to medical care, and other factors contributed to transmission. Information from these investigations has been used in the development of recently released Federal Bureau of Prisons guidance for control of MRSA (*4*), which recommends improvements in inmate hygiene, infection control, and targeted antimicrobial treatment.

Case Definition

For the investigations described in this report, a confirmed case of MRSA infection was defined as illness, compatible with staphylococcal disease, in an inmate with laboratory evidence of MRSA from culture of tissue or blood. A possible case of MRSA was defined as an illness, compatible with staphylococcal infection, in an inmate who had an epidemiologic link to a laboratory-confirmed case but did not have cultures performed. A case of MRSA infection was defined as invasive if MRSA was isolated from cultures of a normally sterile site such as blood or cerebrospinal fluid.

Georgia

Since 2001, the Georgia Division of Public Health has assisted the Georgia Department of Corrections (GDC) and local health departments with three investigations of MRSA skin infection outbreaks in three different types of correctional facilities**.** These investigations are described below.

Investigation 1. During June--September 2001, a total of 11 cases of MRSA skin infections were identified in an all-male, 200-bed, minimum-security state detention center with an average incarceration duration of 90 days. Of the 11 inmates, five had repeated MRSA skin infection occurring after the initial lesion (i.e., recurrent disease). A case-control study identified prolonged (>36 days) incarceration and outdoor work duty as risk factors for MRSA infection. Other possible risk factors included inadequate wound care by medical staff and limited access to soap for hand washing and general bathing (soap was locked in inmate cells away from sinks and showers). In response to this outbreak, the detention center implemented facility-wide screening for skin disease, standardized antimicrobial treatment recommendations, inmate education, and introduction of alcohol-based hand rubs. During December 2001--May 2002, no MRSA cases occurred; however, during June--November 2002, a total of 14 cases

were reported. Staff reviewed previous recommendations for hygiene education with inmates and reinforced proper wound care and antimicrobial use. Chlorhexidine-containing soap was provided daily for 3 days among the entire inmate population. During December 2002--April 2003, five cases of MRSA occurred.

Investigation 2. During April--July 2002, a total of 11 cases of MRSA were reported from a 1,500-bed, maximum-security state prison with an average incarceration duration of 591 days. Infections ranged from small furuncles to deeper abscesses; no deaths or bacteremias occurred, and no inmates were hospitalized. A case-control study identified risk factors, including previous antimicrobial use, self-draining of boils, skin laceration (intentional or accidental), washing clothes by hand, sharing soap, and recent arrival at the prison (since 2001). On the basis of these findings, the prison implemented appropriate laundering, improved access to wound care, increased availability and quantity of soap, and began inmate hygiene education. Monitoring of MRSA infections from the beginning of the outbreak in April 2002 until February 2003 identified 73 inmates with infection, 10 of whom had recurrent disease.

During July--August 2002, a total of 23 cases of MRSA occurred in 19 inmates. Interventions were implemented during late July--August; however, six cases of MRSA occurred among inmates during September--October. In response, in February 2003, the prison housed a cohort of MRSA-infected inmates separately and provided a 5-day supply of chlorhexidine-containing soap for personal hygiene. Despite these measures, during March--May 2003, an additional 29 cases of MRSA were reported. GDC and prison staff are working to improve implementation of recommended interventions for preventing additional cases of MRSA among inmates.

Investigation 3. During June--October 2002, a 2,800-bed county jail with an average incarceration duration of 25 days identified 13 cases of skin lesions, initially thought to be spider bites, from which MRSA was isolated. Three inmates were hospitalized for wound care. A retrospective chart review identified 16 cases and 29 possible cases of MRSA skin infections that had occurred during this period. Infections included folliculitis, furunculosis, and abscess. In December, the jail implemented screening for active skin lesions among the inmates, standardized treatment protocols including treatment with non--beta-lactam antibiotics for suspected *S. aureus* infections, hygiene education for inmates, and changes in laundry practices. Through increased use of bacterial cultures to evaluate skin infections, 59 additional MRSA cases were identified during February--April 2003. A review of medical records of 50 patients who received antimicrobials identified 13 (26%) instances in which beta-lactam antimicrobials were used inappropriately for nine (18%) inmates treated before culture results and for four (8%) inmates treated after results indicated culture-confirmed MRSA.

Los Angeles County, California

The Los Angeles (LA) County jail system, the largest in the country, houses an estimated 20,000 inmates daily and has an average duration of incarceration of 44 days. After an increase in reports of spider bites, the jail developed a protocol in September 2001 that included culture of any lesions suspected to be spider bites. The LA County Department of Health Services (LACDHS) was notified after MRSA was found as the cause of many "spider bite" lesions (*2*). In 2002, a total of 921 MRSA skin infections were identified; 726 (79%) inmates had data available for review. The median time from incarceration to MRSA culture was 45 days (range: 1--1,160 days); 65 (9%) MRSA cases were identified within 5 days after incarceration. During January--June 2003, a total of 776 inmates with MRSA infections were identified (14% identified within 5 days after incarceration), yielding 1,697 cases reported since the jail began surveillance for skin lesions. Investigators observed inadequate infection-control measures in the clinic area; enhanced administrative controls were necessary to ensure frequent showering and appropriate personal hygiene for inmates. LACDHS recommended improvements for skin lesion surveillance, standardized treatment protocols including empiric treatment with non--beta-lactam antimicrobials for all wound infections, hygiene education for inmates, environmental cleaning, and increased frequency of laundry changes. Improvements in antimicrobial treatment of MRSA infections have occurred; however, other recommendations have yet to be implemented fully.

Texas

The Texas Department of Criminal Justice (TDCJ) operates 105 facilities housing 145,000 inmates. In 1996, TDCJ implemented a comprehensive set of treatment and prevention guidelines for MRSA skin infections that included six components: 1) surveillance, 2) hygiene education for inmates, 3) access to proper wound care, 4) standardized antimicrobial therapy based on drug susceptibility data (including directly observed therapy), 5) early treatment of skin disease, and 6) eradication of MRSA from asymptomatic carriers who have recurrent MRSA infections. Since 1998, TDCJ has required culturing of all draining skin lesions and reporting of results to the TDCJ Office of Preventive Medicine. The proportion of *S. aureus* infections that were methicillin-resistant increased from 24% (864 of 3,520) in 1998 to 66% (5,684 of 8,633) in 2002. In December 2000, a case-control study (16 cases and 32 controls) was performed for all cases of MRSA identified during November 2000 at the correctional system's largest intake facility. The study identified previous skin infections and recent close contact with an MRSA-infected inmate as risk factors for infection. Of 10,942 cases of MRSA reported from the beginning of surveillance during January 1996--July 2002, a total of 189 (1.7%) were invasive. The remainder were either unknown site (397 [3.6%]) or skin and soft tissue infections (10,356 [94.6%]). During 1999--2001, three deaths were attributed to MRSA infections. Skin infection screening at the time of incarceration was added to the guidelines in 2003. Implementation of guidelines and a continued multidisciplinary approach to MRSA infections has not led to substantial decreases in the incidence of MRSA. Additional interventions and their effects on infection and carriage are being evaluated, and barriers to efficient implementation of the guidelines are being investigated.

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Editorial Note:

The investigations described in this report identified four factors that contributed to spread of MRSA among inmates. First, investigators identified barriers to routine inmate hygiene. Access to soap often was limited or was restricted for security reasons, and new alcohol-based hand rubs were difficult to introduce because of misuse of these products. Mental health and behavior problems among inmates might have contributed to poor adherence and hindered efforts to improve hygiene. Inmates' clothing was washed by hand or in bulk loads, and potentially contaminated laundry might not have undergone sufficiently high water temperatures or drying to eliminate bacteria. Second, proper access to medical care was hindered by co-payments required for acute care visits and by inadequate supplies and staff for wound care. Third, frequent medical staff turnover was a challenge to providing education on proper infection-control procedures. Finally, MRSA might have been an unrecognized cause of skin infections among inmates; wounds often were attributed to spider bites, and cultures might have been collected infrequently even in cases in which antimicrobial treatment failed.

The emergence of MRSA as a cause of inmate skin and soft tissue infections presents a challenge to correctional facilities, health-care providers, and public health agencies. The potential public health impact of MRSA disease transmission in correctional facilities is substantial; during 2002, approximately 2 million prisoners in the United States were incarcerated at any given time, and one in every 142 U.S. residents was in prison or jail (*5*). Barriers to control of communicable diseases such as viral hepatitis and tuberculosis in correctional facilities are well known (*3,6--8*). Because of these barriers, prisons and jails can serve as amplifiers of MRSA skin disease. In areas where community-associated MRSA appears to be increasing (e.g., LA County), correctional facilities with shorter durations of incarceration might

represent settings in which MRSA is imported from the community and exported back to the community via released inmates.

A strategy to improve hygiene and infection-control practices in correctional facilities will likely be the most effective approach for long-term success. Such a strategy should include 1) skin infection screening and monitoring (e.g., maintaining a log of skin infections and visual skin screening on intake), 2) culturing suspect lesions and providing targeted antimicrobial therapy, 3) efforts to improve inmate hygiene (e.g., education about appropriate hand and body hygiene, appropriate laundering techniques, measures to limit use of shared items, and greater availability of soap), and 4) improved access to wound care and trained health-care staff. Adapting traditional hospital-based approaches to preventing MRSA transmission (e.g., placing infected persons in a separate area or eradicating nasal colonization) might not be feasible in most correctional facilities.

Some state public health agencies have developed their own approaches for addressing MRSA in correctional settings. In July 2003, the Federal Bureau of Prisons issued guidelines to prevent and control MRSA in correctional facilities (*4*). Facilities detecting a substantial number of MRSA infections should implement improved hygiene, infection-control, and treatment practices. Correctional facilities experiencing outbreaks of MRSA should seek assistance from their local and state health departments. Preventing MRSA disease in inmates might be an important measure for preventing MRSA in the community outside the correctional facility. Additional information about MRSA is available at http://www.cdc.gov/ncidod/hip/aresist/mrsa.htm

References

1. CDC. Methicillin-resistant *Staphylococcus aureus* skin or soft tissue infections in a state prison---Mississippi, 2000. MMWR 2001;50:919--22.
2. CDC. Outbreaks of community-associated methicillin-resistant *Staphylococcus aureus* skin infections---Los Angeles County, California, 2002--2003. MMWR 2003;52:88.
3. CDC. Methicillin-resistant *Staphylococcus aureus* infections among competitive sports participants---Colorado, Indiana, Pennsylvania, and Los Angeles County, 2000--2003. MMWR 2003;52:793--5.
4. Federal Bureau of Prisons. Clinical practice guidelines for the management of methicillin-resistant *Staphylococcus aureus* (MRSA) infections (July 2003). Available at http://www.bop.gov/hsdpg/hsdcpgstaph.pdf.
5. Harrison PM, Karberg JC. Bureau of Justice statistics bulletin---prison and jail inmates at midyear 2002. Available at http://www.ojp.usdoj.gov/bjs/prisons.htm.
6. Zack B, Flanigan T, Decarlo P. What is the role of prisons in HIV, hepatitis, STD, and TB prevention? Available at http://www.caps.ucsf.edu/inmaterev.html.
7. Hammett TM, Harmon MP, Rhodes W. The burden of infectious disease among inmates of and releases from US correctional facilities, 1997. Am J Public Health 2002;92:1789--94.
8. Wolfe MI, Xu F, Patel P, et al. An outbreak of syphilis in Alabama prisons: correctional health policy and communicable disease control. Am J Public Health 2001;91:1220--5.

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MMWR

Weekly

October 26, 2001 / 50(42);919-922

Methicillin-Resistant *Staphylococcus aureus* Skin or Soft Tissue Infections in a State Prison --- Mississippi, 2000

On October 25, 2000, the Mississippi State Department of Health (MSDH) notified CDC that, since November 1999, 31 inmates had acquired methicillin-resistant *Staphylococcus aureus* (MRSA) skin or soft tissue infections at a state prison. During November 1998--October 1999, no MRSA infections had been reported at the prison, which houses approximately 1,200 female and 1,800 male inmates. This report summarizes the case investigation and the nasal culture prevalence survey conducted by MSDH and CDC during November 2000. Findings indicate that MRSA infections were transmitted person-to-person within the prison, and that the number of asymptomatic carriers was unexpectedly high for a nonhealth-care setting. Correctional facilities can reduce the increasing prevalence of MRSA disease by identifying and appropriately treating infected persons and by instituting prevention measures.

A case of MRSA infection was defined as a skin or soft tissue lesion occurring in a state prison inmate with symptoms (e.g., pus, pain, warmth, or tenderness) and with MRSA cultured from the site of infection during November 1999--November 2000. Cases were identified by interviews with physicians and inmates and a review of the prison's medical, laboratory, and pharmacy records. Fifty-nine inmates had an illness that met the case definition (Figure 1); 46 (78%) were women, and the median age was 33 years (range: 19--70 years). The median length of incarceration was 397 days (range: 3--3,717 days).

Records of 45 (76%) infected inmates were reviewed. Three (7%) had been hospitalized during the year preceding infection. Twenty-six (58%) had infections on the legs and seven (16%) on the arms. Fifteen (33%) were diagnosed with furuncles, 12 (27%) with skin abscesses, and 11 (24%) with open wounds; 21 (47%) had cellulitis, and two (4%) had systemic infections requiring hospitalization. Infections resolved after a median of 3 weeks (range: 1--36 weeks). Systemic antimicrobials were used to treat 44 (98%) infected inmates, 35 (78%) received topical antimicrobials, six (13%) required incision and drainage, and wound dressing was prescribed for 21 (47%). Nineteen (90%) of the 21 infected inmates with wound dressings changed their dressings themselves. During interviews, 15 (33%) infected inmates reported helping or being helped by other inmates with wound care or dressing changes. Twenty-six (58%) reported lancing their own boils or other inmates' boils with fingernails or tweezers; 40 (89%) shared personal items (e.g., linen, pillows, clothing, and tweezers) that potentially were contaminated by wound drainage.

To assess the extent of MRSA carriage among the inmates, swab specimens of both anterior nares were collected from all female and a one third systematic sample of male inmates. Of 1,757 inmates sampled, 86 (4.9%) were MRSA carriers. More women (73 of 1,241 [5.9%]) were carriers than men (13 of 516 [2.5%]) (p=0.003), and inmates who had been incarcerated for >60 days were more likely to be carriers (84 of 1,565 [5.4%]) than those who had served less time (one of 142 [0.7%]) (p=0.01).

Of the 59 infection-associated isolates, 41 (69%) were tested and genotyped at CDC. All 41 isolates were confirmed as MRSA and 40 (98%) were susceptible to gentamicin, rifampin, trimethoprim-sulfamethoxazole, clindamycin, vancomycin, and chloramphenicol; three (7%) were

resistant to levofloxacin. Pulsed-field gel electrophoresis of isolates revealed that three MRSA strains predominated: genotype A (24 [59%]), genotype B (seven [17%]), and genotype C (four [10%]).

During December 2000, CDC and MSDH provided the Mississippi State Department of Corrections and the prison with control measures such as optimizing antimicrobial treatment of infected inmates, reinforcing infection control practices (e.g., implementing Standard Precautions [*1*] at prison clinics, educating inmates in personal hygiene and wound care), using antibacterial soap, and establishing an MRSA skin infection surveillance system.

Reported by: R Culpepper, MD, R Nolan, MD, S Chapman, MD, Univ of Mississippi Medical Center, Jackson; A Kennedy, MPH, M Currier, MD, State Epidemiologist, Mississippi State Dept of Health. Div of Healthcare Quality Promotion, National Center for Infectious Diseases; and an EIS Officer, CDC.

Editorial Note:

S. aureus is an important and common pathogen in humans. It is found in the nose or on the skin of many healthy, asymptomatic persons (i.e., carriers) and can cause infections with clinical manifestations ranging from pustules to sepsis and death. Most transmission occurs through the contaminated hands of a person infected with or carrying *S. aureus*. MRSA infections frequently are encountered in health-care settings (*2*). Since the 1960s, treatment of these infections has become more difficult because *S. aureus* has progressively acquired resistance to previously effective antimicrobial agents (*2*). In 1999, 2,538 (53.5%) of 4,744 intensive care unit patients with hospital-acquired *S. aureus*-associated infection had MRSA (*3*). Less information is available on long-term--care facilities, where prevalence of MRSA carriage may range from zero to 33% of the residents (*4*).

Risk factors for infection with MRSA in health-care settings include prolonged hospital stay, exposure to multiple or prolonged broad-spectrum antimicrobial therapy, stay in an intensive care or burn unit, proximity to patients colonized or infected with MRSA, use of invasive devices, surgical procedures, underlying illnesses, and MRSA nasal carriage (*5*).

Although community-onset MRSA infections have been reported recently (*6*), little is known about their epidemiology or prevalence of carriage. Community outbreaks have occurred among injection-drug users; aboriginals in Canada, New Zealand, and Australia; Native Americans/Alaska Natives in the United States; and players of close-contact sports (*6*). Reported most commonly have been uncomplicated skin infections; however, community-acquired MRSA infections can be severe. Four deaths from community-acquired MRSA in children were reported in Minnesota and North Dakota in 1999 (*7*).

Disease transmission can occur easily among inmates at correctional facilities. In 1999, approximately two million persons were incarcerated in the United States (*8*). Skin or soft tissue infections are recognized problems in these facilities (*9*). MRSA disease in prisons can be controlled or prevented using several approaches. First, severe skin disease or treatment failures of presumed *S. aureus* skin infection should be evaluated with appropriate cultures or other diagnostic tests. Efforts to monitor the etiology of skin disease should be linked to these data to determine whether MRSA is a problem in the facility. MRSA outbreaks can be reported to CDC (telephone [800] 893-0485) through state departments of corrections and state health departments. Second, optimal treatment of MRSA disease should be based on the infecting organism's antimicrobial susceptibility result and, when available, input by infectious disease expertise. Third, close contact among inmates may place them at increased risk for transmission of skin-colonizing or skin-infecting organisms. To prevent skin disease, all inmates should practice good personal hygiene, including daily showers. Inmates should avoid touching wounds or drainage of others and should have access to sinks and plain soap (in this setting, the usefulness of antibacterial soap is unknown). Hands should be washed with soap as soon as possible after touching wounds or dressings. Personnel that provide wound care should follow Standard Precautions (*1*).

References

1. Garner JS. Guideline for isolation precautions in hospitals. Hospital Infection Control Practices Advisory Committee. Infect Control Hosp Epidemiol 1996;17:53--80.
2. Lowy FD. *Staphylococcus aureus* infections. N Engl J Med 1998;339:520--32.
3. CDC. Semiannual report: aggregated data from the National Nosocomial Infections Surveillance system. Available at <http://www.cdc.gov/ncidod/hip/SURVEILL/NNIS.HTM>. Accessed September 2001.
4. Strausbaugh LJ, Jacobson C, Sewell DL, Potter S, Ward TT. Methicillin-resistant *Staphylococcus aureus* in extended-care facilities: experiences in a Veterans' Affairs nursing home and a review of the literature. Infect Control Hosp Epidemiol 1991;12:36--45.
5. Herwaldt LA. Control of methicillin-resistant *Staphylococcus aureus* in the hospital setting. Am J Med 1999;106:11S--18S,48S--52S.
6. Cookson BD. Methicillin-resistant *Staphylococcus aureus* in the community: new battlefronts, or are the battles lost? Infect Control Hosp Epidemiol 2000;21:398--403.
7. CDC. Four pediatric deaths from community-acquired methicillin-resistant *Staphylococcus aureus*---Minnesota and North Dakota, 1997--1999. MMWR 1999;48:707--10.
8. Beck AJ. Bureau of Justice Statistics Bulletin, prisoners in 1999. Washington, DC: US Department of Justice, Office of Justice Programs, Bureau of Justice Statistics, 2000:16.
9. Duncan WC, Dodge BG, Knox JM. Prevention of superficial pyogenic skin infections. Arch Dermatol 1969;99:465--8.

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Centers for Disease Control and Prevention

MMWR

Weekly

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Public Health Dispatch: Outbreaks of Community-Associated Methicillin-Resistant *Staphylococcus aureus* Skin Infections --- Los Angeles County, California, 2002--2003

During 2002, the Los Angeles County Department of Health Services (LACDHS) investigated three community outbreaks of skin infections associated with methicillin-resistant *Staphylococcus aureus* (MRSA). MRSA commonly has occurred in health-care settings; however, recent investigations of community-associated MRSA (CA-MRSA) have identified infection in various settings, including correctional facilities, athletic teams, and others (CDC, unpublished data, 2002). This report describes investigations of CA-MRSA in Los Angeles County.

In September 2002, LACDHS investigated cases of MRSA infection in two athletes on the same team who were hospitalized with MRSA within the same week. No additional cases of MRSA have been identified. The source of MRSA infection for these patients has not been determined.

On November 22, 2002, physicians from two large infectious disease clinical practices notified LACDHS of MRSA skin infections among men who have sex with men (MSM). LACDHS has increased surveillance in selected clinics serving MSM and has begun a study of risk factors for infection among this population.

Currently, LACDHS is investigating an outbreak in the Los Angeles County Jail, in which 928 inmates had MRSA wound infections diagnosed in 2002. Patients were reported as having spider bites but subsequently were found to be infected with MRSA. Review of medical charts of 39 of the 66 inmates hospitalized with these infections indicated that all initially had skin infections, but 10 later had invasive disease, including bacteremia, endocarditis, or osteomyelitis. The Los Angeles County Jail is the largest jail system in the United States; 165,000 persons are incarcerated in the jail each year. LACDHS issued recommendations for the diagnosis and treatment of skin infections in the jail and is working with the Los Angeles County Sheriff's Department to review policies and procedures on laundry, showers, environmental cleaning, skin care, and control of person-to-person transmission.

In each of these outbreaks, antimicrobial susceptibility patterns from MRSA isolates of these patients have been similar, including resistance to fluoroquinolones. Molecular analysis by pulsed-field gel electrophoresis (PFGE) of isolates performed at the Los Angeles County Public Health Laboratory has identified a predominant strain common to all of these outbreaks. The PFGE pattern of the predominant strain also is consistent with PFGE patterns that CDC has identified in community outbreaks from other parts of the United States (CDC, unpublished data, 2003). Selected MRSA isolates will be sent to CDC to characterize their virulence factors and toxins.

LACDHS is advising health-care providers to be aware that MRSA is a documented cause of community-associated skin and soft tissue infections. Local treatment and incision and drainage remain first-line therapies for soft tissue infections. Clinicians who suspect MRSA skin and soft tissue infections

should consider microbiologic culture of wounds and appropriate antimicrobial therapy.

Skin infections might be prevented by keeping cuts and abrasions clean by washing with soap and water. Previous investigations of MRSA infection clusters in community settings have identified MRSA transmission through sharing common objects (e.g., athletic equipment, towels, benches, and personal items) contaminated with MRSA (CDC, unpublished data, 2002). To prevent MRSA infections from spreading in health-care settings, health-care providers should use standard precautions and appropriate hand hygiene between treating patients, clean surfaces of examination rooms with commercial disinfectant or diluted bleach (1 tablespoon bleach in 1 quart water), and carefully dispose of dressings and other materials that come into contact with pus, nasal discharge, blood, and urine (*1*).

The outbreaks described in this report reflect the importance of CA-MRSA infections. In collaboration with state health departments, CDC is conducting active, population-based surveillance for CA-MRSA in selected regions of the United States to help characterize the incidence and risk factors for MRSA in the community.

Reported by: *Participating physicians and microbiologists; Los Angeles County Jail; Los Angeles County Dept of Health Svcs, Los Angeles County, California. Div of Healthcare Quality Promotion, National Center for Infectious Diseases, CDC.*

Reference

1. CDC. Guideline for hand hygiene in health-care settings: recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. MMWR 2002;51(No. RR-16).

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Risk Factors for Community-Associated Methicillin-Resistant *Staphylococcus aureus* Infections in an Outbreak of Disease among Military Trainees in San Diego, California, in 2002†

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An outbreak of community-associated methicillin-resistant *Staphylococcus aureus* (CA-MRSA) skin infections was observed in a population of U.S. military trainees in the summer of 2002. A questionnaire was developed and administered to 206 trainees, 22 of whom had MRSA infections. Factors associated with infection were described by multivariable logistic regression modeling and included having a roommate in training with a prior skin infection (odds ratio [OR] = 3.44) or having a family member or friend who worked in a health care setting (OR = 2.79). Previous antibiotic use, hospitalization, or health problems were not associated with MRSA infection. This outbreak of MRSA skin infections in an otherwise-healthy, well-defined, military population provided an opportunity to describe risk factors for CA-MRSA which may help focus prevention efforts in this and other communities.

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Mounting evidence has confirmed that methicillin-resistant *Staphylococcus aureus* (MRSA), once based almost exclusively in health care facilities, is emerging as a community-based pathogen. Recent reports indicate that the prevalence of community-associated MRSA (CA-MRSA) infections is increasing (1, 4, 14, 17, 18, 22, 26), but even more concerning are the recent, numerous CA-MRSA outbreaks in groups of young, healthy individuals with no direct ties to health care facilities and none of the typical risk factors for

infection (6-10, 15, 16, 20, 24).

Among the risk factors for CA-MRSA infection identified in previous investigations are prior antibiotic use, prior hospitalization, close contact with an MRSA-infected or -colonized individual, injection drug use, and underlying illnesses (3, 5, 11, 27-29, 31). As CA-MRSA infections continue to become more widespread, additional investigation into the risk factors for infection will be vital to the development and implementation of effective prevention and control measures. In this investigation, we examined potential risk factors for CA-MRSA infection in a population of military trainees.

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Population. Young, healthy males who were enrolled in a 26-week, physically demanding military training program comprised the population for this investigation. During the course of the program, trainees lived and worked closely together and rarely left the training facility. As a result of this closed environment, trainees experienced relatively uniform exposures. Due to their frequent contact with sand, boats, equipment, and seawater during their training regimen, trainees historically experienced a high occurrence of skin abrasions (L. Garsha [U.S. Navy, San Diego, Calif.], personal communication, Sept. 2002).

Outbreak identification. The first MRSA case was identified by the presence of cellulitis and a positive wound culture on 2 August 2002. Between 2 August and 28 October 2002 (12 weeks), a total of 34 MRSA skin infections were confirmed (Fig. 1). Four of those infections occurred in trainees that had experienced a previous MRSA infection during this same 12-week period, and these were identified as repeat infections. The incidence of MRSA skin infection during this period was calculated as 9.5 cases per 1,000 person-weeks. This was considered markedly higher than the baseline rate of cellulitis in this population, estimated at 3 cases per 1,000 person-weeks (L. Garsha, personal communication).

Laboratory methods. Staphylococcal isolates from binasal swab specimens and wound cultures were sent to the Department of Defense Center for Deployment Health Research, San Diego, Calif., for additional molecular epidemiology analysis.

Clinical isolates were confirmed to be *S. aureus* by colony morphology, Gram stain, positive MRSA latex agglutination (Oxoid), and positive tube coagulase tests. In addition, a multiplex PCR was used to detect the *mecA* and *nucA* genes to confirm identification of MRSA isolates (21).

The susceptibilities of these MRSA isolates to different antibiotics were determined by the broth microdilution method following the recommendations of the National Committee for Clinical Laboratory Standards guidelines (23). Penicillin, trimethoprim-sulfamethoxazole, levofloxacin, clindamycin, erythromycin, ceftriaxone, rifampin, tetracycline, and vancomycin were tested. Additional resistance determinations for mupirocin and oxacillin were performed with the E-test (AB Biodisk, Solna, Sweden) method. Resistance to oxacillin was defined as an MIC of ≥4 μg/ml. *S. aureus* ATCC 25912 and *S. aureus* ATCC 43300 were used as control strains susceptible and resistant to methicillin, respectively.

Clinical isolates were further evaluated by molecular methods for the presence

of the Panton-Valentine leukocidin (*PVL*) gene, and sequence type (ST) was determined using the multilocus sequence typing method (12, 13, 19, 21).

Outbreak intervention. During the course of the outbreak, trainees and staff had their nares cultured several times to identify potential sources of MRSA carriage in this population. In addition, several measures were implemented in the trainee population to reduce the spread of infection. All trainees were required to apply mupirocin to their nares and to bathe with an antimicrobial skin cleanser on three separate occasions. In addition, the barracks were routinely disinfected with a 5% bleach solution.

Postoutbreak survey. As part of the outbreak investigation, a postoutbreak survey was developed to describe potential risk factors for CA-MRSA infection in this population. An optically scannable questionnaire was administered to 206 military trainees, representing approximately 70% of the available military trainee population, in October 2002.

Data captured by the survey included demographic characteristics and medical characteristics, including prior antibiotic use, prior hospitalizations, medications, allergies, and past medical history. Past medical history included questions about prior skin conditions. Trainees were also asked to provide information about dietary supplement use, tobacco and alcohol use, travel history, whether their roommate had been treated for a skin infection, whether any members of their crew had been treated for a skin infection, whether they had a family member or friend who worked in a health care setting, and whether they had a family member who had recently been hospitalized or had an outpatient procedure.

Self-reported data on prior hospitalizations, prior antibiotic use, and medication allergies were verified by medical records.

Statistical analyses. After descriptive investigation of population characteristics, analyses were performed to assess the significance of associations between the outcome (MRSA infection) and demographic and exposure variables. Using regression diagnostics, colinearity among variables was assessed. A manual backward stepwise logistic regression was conducted, with variables considered for inclusion in the model if initial significance was characterized by *P* values of <0.15 from the univariate analysis. All covariates were investigated as possible confounders prior to removing them from further modeling. Multivariable logistic regression modeling was performed; the reduced model included only those variables with significance characterized by a *P* value of <0.05 or otherwise identified as possible confounders. Results were reported as odds ratios (ORs) and 95% confidence intervals (CIs) calculated for variables associated with MRSA infection. SAS software (version 8.0; SAS Institute, Cary, N.C.) was used for analyses.

This research was conducted in compliance with all applicable federal regulations governing the protection of human subjects in research.

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Based on testing of nasal swab specimens and wound cultures, military trainees were classified as MRSA infected, MRSA colonized, or MRSA negative. Trainees who had a skin infection and tested positive for MRSA by wound culture of the infected area were classified as MRSA infected. Trainees who did not have a skin infection but whose nasal swab specimen tested positive for

MRSA were classified as MRSA colonized. Trainees who did not have a skin infection and whose nasal swab specimen did not test positive for MRSA were classified as MRSA negative. Of the 206 military trainees surveyed, 10.7% (*n* = 22) were MRSA infected, 1.9% (*n* = 4) were MRSA colonized, and 87.4% (*n* = 180) were MRSA negative. Due to the small number, data from the four MRSA-colonized individuals were not included in further statistical analyses, although the complete laboratory testing battery was performed on the isolates.

Questionnaire data for the remaining 202 trainees indicated that 77.2% were Caucasian, 67.4% were younger than 25 years old, 32.2% reported antibiotic use within the past 12 months, 16.8% reported a hospitalization within the past 24 months, 6.5% reported current dietary supplement use, 43.1% reported any tobacco use, and 46.5% reported current alcohol use (Table 1).

The variables identified through univariate analyses as being significantly associated with MRSA infection included antibiotic use within the 12 months prior to training ($P = 0.123$), dietary supplement use prior to training ($P = 0.110$), having a roommate in training with a prior skin infection ($P = 0.003$), having a family member or friend who worked in a health care setting ($P = 0.013$), and having a parent or member of the household who smoked during the trainee's childhood ($P = 0.007$). Two variables were identified in the reduced logistic regression model as having a significant positive association with MRSA infection. Military trainees who reported having a roommate in training with a prior skin infection had 3.4 times higher odds of becoming infected with MRSA than trainees who did not report having a roommate with a skin infection (OR = 3.44; 95% CI, 1.34 to 8.85). Trainees who reported having a family member or friend who worked in a health care setting had 2.8 times higher odds of becoming infected with MRSA than trainees who did not report such ties to the health care field (OR = 2.79; 95% CI, 1.09 to 7.15) (Table 1). Conversely, having a parent or other household member who smoked during the trainee's childhood was negatively associated with MRSA infection; trainees who reported this appeared less likely to develop an MRSA infection than those who did not report such environmental tobacco exposure (OR = 0.26; 95% CI, 0.07 to 0.94).

Laboratory results. Staphylococcal isolates from all 22 MRSA-infected individuals tested positive for the *mecA* and *PVL* genes. In addition, all 22 isolates were identified as ST8 by multilocus sequence typing. Three of the four isolates from MRSA-colonized individuals were also identified as ST8, while the remaining isolate was identified as ST30. Antibiotic susceptibility testing showed resistance of all isolates to oxacillin, penicillin, erythromycin, and ceftriaxone. The isolates were susceptible to all other antibiotics tested.

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The steady increase in reports of CA-MRSA outbreaks in young, healthy populations with no apparent risk factors for infection is concerning. With each outbreak, it is important to determine the possible risk factors for infection in order to focus prevention and control efforts.

This outbreak of CA-MRSA occurred in a young, healthy, and well-defined population of military trainees. During the course of their 26-week intense training regimen, these trainees lived and worked closely together. In this environment, a small number of initial MRSA cases quickly became noticed as an outbreak.

The control measures implemented within this military trainee population during the summer and fall of 2002 were apparently effective in stopping the MRSA outbreak. During its 12-week course, however, the affected population incurred a high cost from infections. At least six trainees were hospitalized due to their MRSA infection, and eight trainees were unable to complete their original training program and therefore had to restart. Although these hospitalization and lost-time rates were higher than would be expected for a healthy trainee population, the “voluntary drop” rate for this trainee population was actually much lower than expected. Only one trainee reported dropping the training program after his MRSA infection.

In this outbreak investigation, the major risk factor associated with MRSA infection was having a roommate during training who had a prior skin infection. This finding is consistent with data from previous studies that identified close contact with an MRSA-infected or -colonized individual as a risk factor for infection (11, 29). Another risk factor associated with MRSA infection in this outbreak was having a family member or friend who worked in a health care setting. This finding suggests that this CA-MRSA outbreak may have had indirect ties to health care facilities from trainees' past contact with family and friends, a factor that has also been suggested in previous studies of MRSA infection (27). Finally, the statistical analyses identified having a parent or other household member who smoked during the trainee's childhood as protective against MRSA infection. Although difficult to explain, one might speculate that childhood environmental tobacco smoke exposure is a surrogate for another factor(s), perhaps immunologic, that is protective against infection. Note than none of these trainees had asthma or reactive airway disease; therefore, those exposed to environmental smoke as children may represent a subgroup with especially strong immune profiles (2).

From previous studies, it is important to note that other factors found associated with CA-MRSA infection, including past antibiotic use and prior hospitalization, were not found to be associated with MRSA infection in this present investigation. This implies that this population of otherwise healthy, strong, young adults may be different from other populations affected by MRSA.

The results of the laboratory testing of staphylococcal isolates conducted in this outbreak investigation were consistent with those of other CA-MRSA outbreaks. The isolates in this outbreak were primarily susceptible to the antibiotics tested, except for beta-lactams and erythromycin. This finding is consistent with antibiotic susceptibility patterns reported in previous CA-MRSA outbreaks. In addition, this finding contrasts sharply with the multidrug resistance patterns often observed with nosocomial MRSA infections (4, 6, 11, 16, 25, 29). The presence of the *mecA* gene in the 22 isolates is consistent with the finding of methicillin resistance among these pathogens (21). In addition, the *PVL* gene is a potential virulence factor that has been linked to other CA-MRSA infections (19, 30). Finally, the identification of all 22 MRSA skin isolates as ST8 by multilocus sequence typing indicates that a single MRSA clone was transmitted in this outbreak. Community- and hospital-acquired MRSA outbreaks with ST8 have been identified previously within the United States (30).

The limitations of this study include the small sample size and the unique population. As a result, the findings of this investigation may not be generalizable. There are inherent limitations to the use of survey data, including recall and response biases. It may be notable that the 70% response rate was strong, and some survey data were confirmed via medical record review.

Despite limitations, this outbreak investigation included strengths that may contribute to our expanding understanding of CA-MRSA infections. Most notably, the outbreak occurred in a well-defined population of young, healthy, military trainees who experienced relatively uniform exposures in their environment. In this controlled setting, one may have more confidence that factors found to be associated with infection are true risk factors.

The control measures implemented during this outbreak may have helped reduce the transmission of MRSA between trainees who had close contact but were not roommates, such as trainees who were members of the same crew. However, the data suggest that control measures did not eliminate the risk of MRSA transmission between roommates. Targeting education, hygiene, and personal behaviors may be key to reducing the spread of MRSA among those with close physical contact in future outbreaks. Future studies may also explore the immunologic mechanisms that appear to make some otherwise healthy adults at higher risk for MRSA infections.

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FOOTNOTES

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1. **Abi-Hanna, P., A. L. Frank, J. P. Quinn, S. Kelkar, P. C. Schreckenberger, M. K. Hayden, and J. F. Marcinak.** 2000. Clonal features of community-acquired methicillin-resistant Staphylococcus aureus in children. Clin. Infect. Dis. 30**:**630-631. [PubMed] [Full Text].

2. **Babu, K. S., and S. H. Arshad.** 2003. The role of allergy in the development of airway inflammation in children. Paediatr. Respir. Rev. 4**:**40-46. [PubMed] [Full Text].

3. **Borer, A., J. Gilad, P. Yagupsky, N. Peled, N. Porat, R. Trefler, H. Shprecher-Levy, K. Riesenberg, M. Shipman, and F. Schlaeffer.** 2002. Community-acquired methicillin-resistant Staphylococcus aureus in institutionalized adults with developmental disabilities. Emerg. Infect. Dis. 8**:**966-970. [PubMed].

4. **Bukharie, H. A., M. S. Abdelhadi, I. A. Saeed, A. M. Rubaish, and**

E. B. Larbi. 2001. Emergence of methicillin-resistant Staphylococcus aureus as a community pathogen. Diagn. Microbiol. Infect. Dis. 40**:**1-4. [PubMed] [Full Text].

5. **Centers for Disease Control and Prevention.** 1981. Community-acquired methicillin-resistant Staphylococcus aureus infections—Michigan. Morb. Mortal. Wkly. Rep. 30**:**185-187.

6. **Centers for Disease Control and Prevention.** 1999. Four pediatric deaths from community-acquired methicillin-resistant Staphylococcus aureus—Minnesota and North Dakota, 1997-1999. JAMA 282**:**1123-1125. [PubMed] [Full Text].

7. **Centers for Disease Control and Prevention.** 2003. Methicillin-resistant Staphylococcus aureus infections among competitive sports participants—Colorado, Indiana, Pennsylvania, and Los Angeles County, 2000-2003. Morb. Mortal. Wkly. Rep. 52**:**793-795.

8. **Centers for Disease Control and Prevention.** 2003. Methicillin-resistant Staphylococcus aureus infections in correctional facilities—Georgia, California, and Texas, 2001-2003. Morb. Mortal. Wkly. Rep. 52**:**992-996.

9. **Centers for Disease Control and Prevention.** 2001. Methicillin-resistant Staphylococcus aureus skin or soft tissue infections in a state prison—Mississippi, 2000. Morb. Mortal. Wkly. Rep. 50**:**919-922.

10. **Centers for Disease Control and Prevention.** 2003. Outbreaks of community-associated methicillin-resistant Staphylococcus aureus skin infections—Los Angeles County, California, 2002-2003. Morb. Mortal. Wkly. Rep. 52**:**88.

11. **Chambers, H. F.** 2001. The changing epidemiology of Staphylococcus aureus? Emerg. Infect. Dis. 7**:**178-182. [PubMed].

12. **Dufour, P., Y. Gillet, M. Bes, G. Lina, F. Vandenesch, D. Floret, J. Etienne, and H. Richet.** 2002. Community-acquired methicillin-resistant Staphylococcus aureus infections in France: emergence of a single clone that produces Panton-Valentine leukocidin. Clin. Infect. Dis. 35**:**819-824. [PubMed] [Full Text].

13. **Enright, M. C., N. P. Day, C. E. Davies, S. J. Peacock, and B. G. Spratt.** 2000. Multilocus sequence typing for characterization of methicillin-resistant and methicillin-susceptible clones of Staphylococcus aureus. J. Clin. Microbiol. 38**:**1008-1015. [Free Full text in PMC].

14. **Frank, A. L., J. F. Marcinak, P. D. Mangat, and P. C. Schreckenberger.** 1999. Increase in community-acquired methicillin-resistant Staphylococcus aureus in children. Clin. Infect. Dis. 29**:**935-936. [PubMed].

15. **Gorak, E. J., S. M. Yamada, and J. D. Brown.** 1999.

Community-acquired methicillin-resistant Staphylococcus aureus in hospitalized adults and children without known risk factors. Clin. Infect. Dis. 29:797-800. [PubMed].

16. **Herold, B. C., L. C. Immergluck, M. C. Maranan, D. S. Lauderdale, R. E. Gaskin, S. Boyle-Vavra, C. D. Leitch, and R. S. Daum.** 1998. Community-acquired methicillin-resistant Staphylococcus aureus in children with no identified predisposing risk. JAMA 279:593-598. [PubMed] [Full Text].

17. **Kallen, A. J., T. J. Driscoll, S. Thornton, P. E. Olson, and M. R. Wallace.** 2000. Increase in community-acquired methicillin-resistant Staphylococcus aureus at a Naval Medical Center. Infect. Control Hosp. Epidemiol. 21:223-226. [PubMed].

18. **Layton, M. C., W. J. Hierholzer, Jr., and J. E. Patterson.** 1995. The evolving epidemiology of methicillin-resistant Staphylococcus aureus at a university hospital. Infect. Control Hosp. Epidemiol. 16:12-17. [PubMed].

19. **Lina, G., Y. Piémont, F. Godail-Gamot, M. Bes, M. O. Peter, V. Gauduchon, F. Vandenesch, and J. Etienne.** 1999. Involvement of Panton-Valentine leukocidin-producing Staphylococcus aureus in primary skin infections and pneumonia. Clin. Infect. Dis. 29:1128-1132. [PubMed] [Full Text].

20. **Lindenmayer, J. M., S. Schoenfeld, R. O'Grady, and J. K. Carney.** 1998. Methicillin-resistant Staphylococcus aureus in a high school wrestling team and the surrounding community. Arch. Intern. Med. 158:895-899. [PubMed] [Full Text].

21. **Louie, L., S. O. Matsumura, E. Choi, M. Louie, and A. E. Simor.** 2000. Evaluation of three rapid methods for detection of methicillin resistance in Staphylococcus aureus. J. Clin. Microbiol. 38:2170-2173. [Free Full text in PMC].

22. **Moreno, F., C. Crisp, J. H. Jorgensen, and J. E. Patterson.** 1995. Methicillin-resistant Staphylococcus aureus as a community organism. Clin. Infect. Dis. 21:1308-1312. [PubMed].

23. **National Committee for Clinical Laboratory Standards.** 2002. Methods for dilution antimicrobial susceptibility tests for bacteria that grow aerobically, 5th ed. Approved standard M7-A5. National Committee for Clinical Laboratory Standards, Wayne, Pa.

24. **Pan, E. S., B. A. Diep, H. A. Carleton, E. D. Charlebois, G. F. Sensabaugh, B. L. Haller, and F. Perdreau-Remington.** 2003. Increasing prevalence of methicillin-resistant Staphylococcus aureus infection in California jails. Clin. Infect. Dis. 37:1384-1388. [PubMed] [Full Text].

25. **Saïd-Salim, B., B. Mathema, and B. N. Kreiswirth.** 2003. Community-acquired methicillin-resistant Staphylococcus aureus: an emerging pathogen. Infect. Control Hosp. Epidemiol. 24:451-455. [PubMed].

26. **Saiman, L., M. O'Keefe, P. L. Graham III, F. Wu, B. Saïd-Salim, B. Kreiswirth, A. LaSala, P. M. Schlievert, and P. Della-Latta.** 2003. Hospital transmission of community-acquired methicillin-resistant Staphylococcus aureus among postpartum women. Clin. Infect. Dis. 37**:**1313-1319. [PubMed] [Full Text].

27. **Salgado, C. D., B. M. Farr, and D. P. Calfee.** 2003. Community-acquired methicillin-resistant Staphylococcus aureus: a meta-analysis of prevalence and risk factors. Clin. Infect. Dis. 36**:**131-139. [PubMed] [Full Text].

28. **Saravolatz, L. D., N. Markowitz, L. Arking, D. Pohlod, and E. Fisher.** 1982. Methicillin-resistant Staphylococcus aureus. Epidemiologic observations during a community-acquired outbreak. Ann. Intern. Med. 96**:**11-16. [PubMed].

29. **Saravolatz, L. D., D. J. Pohlod, and L. M. Arking.** 1982. Community-acquired methicillin-resistant Staphylococcus aureus infections: a new source for nosocomial outbreaks. Ann. Intern. Med. 97**:**325-329. [PubMed].

30. **Vandenesch, F., T. Naimi, M. C. Enright, G. Lina, G. R. Nimmo, H. Heffernan, N. Liassine, M. Bes, T. Greenland, M. E. Reverdy, and J. Etienne.** 2003. Community-acquired methicillin-resistant Staphylococcus aureus carrying Panton-Valentine leukocidin genes: worldwide emergence. Emerg. Infect. Dis. 9**:**978-984. [PubMed] [Free Full Text].

31. **Warshawsky, B., Z. Hussain, D. B. Gregson, R. Alder, M. Austin, D. Bruckschwaiger, A. H. Chagla, J. Daley, C. Duhaime, K. McGhie, G. Pollett, H. Potters, and L. Schiedel.** 2000. Hospital- and community-based surveillance of methicillin-resistant Staphylococcus aureus: previous hospitalization is the major risk factor. Infect. Control Hosp. Epidemiol. 21**:**724-727. [PubMed].

FIGURES AND TABLES

FIG. 1. **FIG. 1.**
Number of MRSA cases in the military trainee population during each week of the 2002 outbreak.

TABLE 1. **TABLE 1.**
Characteristics of survey responders and associations with MRSA infection