

Heterosexual Transmission of Community-Associated Methicillin-Resistant *Staphylococcus aureus*

Heather A. Cook,¹ E. Yoko Furuya,¹ Elaine Larson,² Glenn Vasquez,¹ and Franklin D. Lowy^{1,2}

Departments of ¹Medicine and ²Pathology, Division of Infectious Diseases, College of Physicians and Surgeons, and ³School of Nursing, Columbia University, New York, New York

Heterosexual transmission of community-associated methicillin-resistant *Staphylococcus aureus* has not been documented. As part of a survey conducted in northern Manhattan, we encountered 3 households in which heterosexual transmission was responsible for new community-associated methicillin-resistant *S. aureus* infection. The vaginal and inguinal isolates obtained from the sexual partners were USA 300. This report documents an important and previously unrecognized means of community-associated methicillin-resistant *S. aureus* colonization and transmission for these potentially invasive strains.

Community-associated (CA) methicillin-resistant *Staphylococcus aureus* (MRSA) has emerged as a major cause of cutaneous and invasive infections [1–3]. CA-MRSA infection occurs in a wide range of individuals, including members of sports teams, military recruits, and children in day care facilities [4, 5]. Increasingly, reports have also suggested behavioral risks, including injection drug use and poor personal hygiene [4, 6–8]. Absent from this list have been reports of heterosexual activity as a potential means of CA-MRSA transmission. This potential means of transmission might help to explain the ability of these new strains to become established in what would otherwise be considered low-risk communities. In this report, we describe 3 households in which heterosexual transmission of CA-MRSA is likely to have occurred.

Methods. Subjects with cultures positive for MRSA were asked to participate in a prospective, community-based study

of the prevalence of CA-MRSA infection in the Columbia University Medical Center (CUMC; New York, NY) catchment area. The study was conducted from April 2004 to September 2006. MRSA-positive individuals were identified by surveillance of the CUMC clinical microbiology database or by physician referral. Those who agreed to participate were interviewed in their homes. Sociodemographic and medical information, as well as data pertaining to potential risk factors for CA-MRSA infection (including sexual behavior), was collected for the index case patient and for all household members. Nasal samples, axillary samples, and samples of self-administered vaginal and genital swabs were collected from all consenting adult household members and cultured for *S. aureus*. Samples from visible skin lesions were also cultured. Follow-up interviews were performed, when possible, every 3 months for up to 9 months.

All cultures positive for *S. aureus* were further characterized by staphylococcal chromosomal cassette (SCC) *mec* typing [9, 10] and PFGE [11]. PFGE profiles were entered into the Bionumerics archival database (Applied Maths), and the strains were compared [12]. Screening for the presence of the Pantone-Valentine leukocidin was performed as described elsewhere [13]. This study was approved by the Columbia University Institutional Review Board.

Case reports. There were 3 instances of heterosexual transmission of CA-MRSA. In each instance, sexual partners described a history of recurrent CA-MRSA infection, often involving the pubic, vaginal, or perineal region.

Household 1 was enrolled when a 3-year-old girl in the household presented to the CUMC emergency department with an MRSA-positive abscess in the pubic area. The girl's mother (patient 1) reported having tiny "pimples" in her groin area that had appeared 6 months earlier, when she was sexually active with 5 different male partners, including her husband. She stated that all partners except her husband had used condoms. She recalled that both her husband and another partner had similar "pimples" in the groin. The woman also reported that she shaved her pubic area and that she had received a diagnosis of vaginal herpes shortly after her initial vaginal cultures were positive for CA-MRSA (figure 1).

Both the husband's and the wife's nasal cultures were negative for CA-MRSA. The wife's vaginal swab sample and the husband's groin sample were both positive for CA-MRSA. Both isolates were SCC*mec* type IV and were identical by PFGE (figure 2). The mother remained culture positive with the identical strain on 3 separate visits (figure 1).

Household 2 was enrolled when patient 2 presented to the

Received 14 August 2006; accepted 19 October 2006; electronically published 2 January 2007.

Reprints or correspondence: Dr. Franklin D. Lowy, Div. of Infectious Diseases, Box 82, Columbia University, College of Physicians and Surgeons, 630 W. 168th Street, New York, NY 10032 (fl189@columbia.edu).

Clinical Infectious Diseases 2007;44:410–3

© 2007 by the Infectious Diseases Society of America. All rights reserved.
1058-4838/2007/4403-0016\$15.00

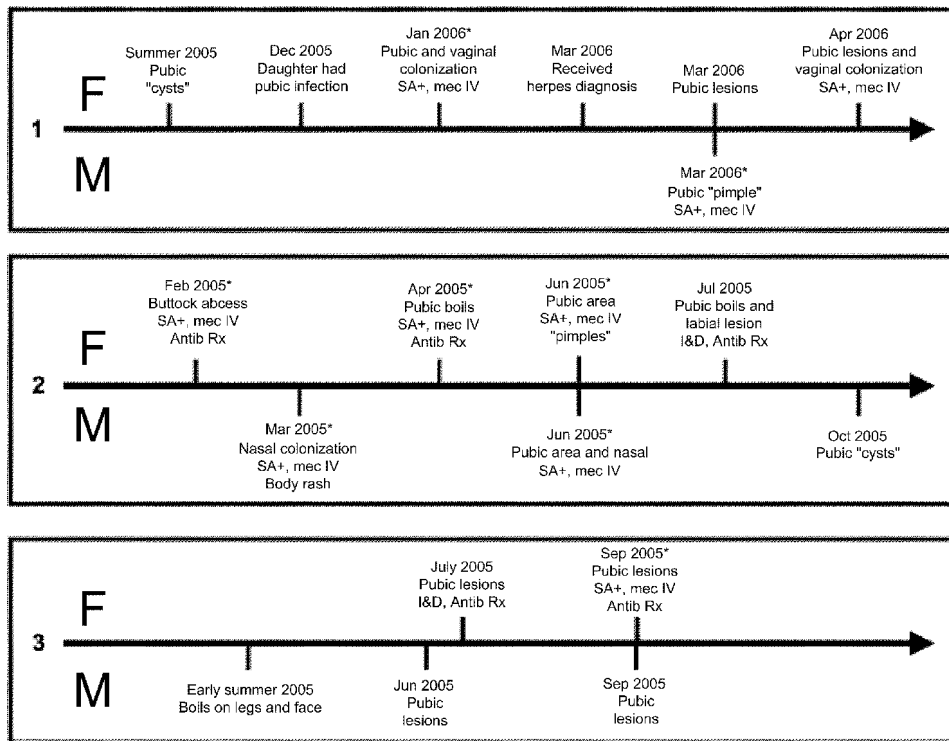


Figure 1. Timeline of events related to colonization and infection of sexual partners with community-associated methicillin-resistant *Staphylococcus aureus* (CA-MRSA) in 3 households. Asterisk indicates strains displayed in figure 2. Antib Rx, antibiotic treatment; F, female subject; I&D, incision and drainage; M, male subject; mec IV, staphylococcal chromosomal cassette *mec* type IV; SA+, culture positive for *S. aureus*.

CUMC emergency department with an MRSA-positive buttock abscess that resolved after incision and drainage and treatment with trimethoprim-sulfamethoxazole. Two months later, her husband developed a “full-body rash” and “boils” that were culture positive for CA-MRSA. He was treated with unknown antibiotics. At the same time, patient 2 developed boils in her groin area and was treated with clindamycin. The abscesses failed to resolve, and she eventually underwent incision and drainage. She was also treated with trimethoprim-sulfamethoxazole and mupirocin ointment. Patient 2 and her husband were sexually active with each other during this time (figure 1).

Cultures of nasal samples obtained from patient 2 were repeatedly negative for MRSA, whereas cultures of nasal samples obtained from her husband were positive for MRSA (SCC*mec* type IV). The vaginal swab sample obtained from patient 2 and the groin swab sample obtained from her husband were both positive for MRSA SCC*mec* type IV. These samples were identical by PFGE (figure 2). Both husband and wife had multiple cultures that were positive for CA-MRSA over time.

Household 3 was enrolled when patient 3 reported multiple episodes of MRSA-positive abscesses over a 3-month period. These episodes always followed visits from her boyfriend, a member of the military whose unit had reportedly been experiencing an outbreak of MRSA infection. The boyfriend had boils on his face and groin and was treated with antibiotics

combined with incision and drainage. Patient 3 had abscesses on her legs, groin, and buttocks that were also treated with antibiotics and incision and drainage. This led to resolution of her symptoms until the next visit from her boyfriend, after which the abscesses recurred (figure 1). Notably, patient 3 also regularly shaved her pubic area. The isolate obtained from patient 3’s groin sample was SCC*mec* type IV. Her nasal cultures had persistently negative results. The boyfriend’s isolate was unavailable for typing.

Microbiologic results. MRSA isolates from vaginal or pubic samples obtained from sexual partners in households 1 and 2 were indistinguishable by PFGE. Nares specimens from 4 of the 5 subjects tested were negative for MRSA during the time periods that cultures of vaginal or pubic samples were positive for MRSA. Of interest, all isolates were positive for Pantone-Valentine leukocidin and matched the profile of USA 300, the predominant CA-MRSA clone in the United States (figure 2) [14].

Subjects from 114 (33.0%) of 345 eligible households identified through the clinical microbiology database (for the period 1 December 2003 through 16 March 2006) were enrolled in the study. The primary site of MRSA infection was the pubic area for 10 (2.9%) of the eligible index case patients (4 male patients and 6 female patients). This likely underestimates the total number of patients with infection in the pubic area, because many of the index case patients were children, and other

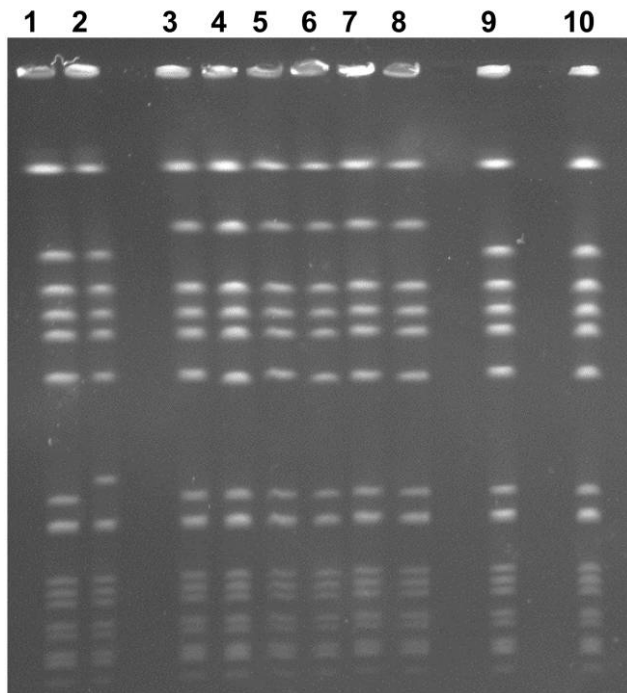


Figure 2. PFGE analysis of isolates of community-associated methicillin-resistant *Staphylococcus aureus* (CA-MRSA) obtained in 3 households. *Lane 1*, isolate from vaginal culture sample obtained January 2006 from the female subject from household 1; *lane 2*, isolate from groin area culture sample obtained March 2006 from the male subject from household 1; *lane 3*, isolate from nares culture sample obtained March 2005 from the male subject from household 2; *lane 4*, isolate from leg (body rash) culture sample obtained March 2005 from the male subject from household 2; *lane 5*, isolate from groin area culture sample obtained June 2005 from the male subject from household 2; *lane 6*, isolate from pubic area culture sample obtained April 2005 from the female subject from household 2; *lane 7*, isolate from pubic area culture sample obtained June 2005 from the female subject from household 2; *lane 8*, isolate from buttock abscess culture sample obtained February 2005 (the original clinical isolate) from the female subject from household 2; *lane 9*, isolate from original pubic pustule culture sample obtained September 2005 from female subject in household 3; and *lane 10*, PFGE profile of USA 300 isolate.

household members might have had positive cultures of samples from these sites (e.g., patient 1).

Of the 32 female subjects who agreed to perform self-administered swabs of the pubic area and/or vagina, 8 (25%) had samples that tested positive for MRSA; 4 had positive vaginal and pubic samples, 2 had positive vaginal samples only, and 2 had positive pubic samples only. Only 2 (25%) of these 8 subjects had concurrent nares cultures that were positive for MRSA. Two MRSA isolates were SCC*mec* type II, and the remaining 6 isolates were SCC*mec* type IV.

Discussion. In this report, we describe 3 households in which there was clinical, microbiological, and molecular epidemiological evidence of heterosexual transmission of CA-

MRSA. The sexual partners developed colonization with successive skin infections in the pelvic region after sexual activity. These infections were due to identical CA-MRSA strains within 2 of the 3 households. We also found that a number of women had asymptomatic vaginal or pubic colonization with MRSA, and in 75% of these cases, nares cultures showed no growth.

Heterosexual activity reproduces many of the previously identified risk factors for CA-MRSA transmission, including intimate contact, the presence of open wounds or minor abrasions (e.g., from shaving or the result of *Herpes simplex* virus infection), and the failure to adequately cover sites of infection [15, 16]. Similar risk factors, including having a sexual partner with skin infection, have been documented among HIV-positive men who have sex with men [16]. Heterosexual activity, however, poses a far greater risk of dissemination in the community. In this regard, CA-MRSA infection can be regarded as a sexually transmitted disease, not unlike *Herpes simplex* virus infection, with the risk of transmission increasing in the presence of other sexually transmitted diseases and/or multiple sexual partners.

Some authors have speculated that nasal colonization may not precede CA-MRSA infection as often as it precedes health care-associated MRSA infection [17, 18]. This has raised the possibility that there are other unrecognized sites of colonization serving as reservoirs for subsequent infection. Rates of nasal colonization with CA-MRSA in the general population have been low [19, 20]. However, in some groups at high risk for CA-MRSA infection (such as children, the homeless, and the military), nasal colonization rates have been high, whereas in other groups (such as athletes), the rates of nasal colonization have been low [4–6, 21, 22]. In our study, nasal colonization could not be documented in 75% of persons with active infection or colonization at another site. Moreover, the culture information retrieved from the clinical microbiology database suggests that colonization of alternative sites is relatively common. This information, taken in concert with the results of the self-administered vaginal swab cultures, demonstrates that other colonization sites are important as potential CA-MRSA reservoirs for infection and transmission.

It is surprising that heterosexual activity has not been previously documented as a potentially important means of CA-MRSA transmission. Our longitudinal, community-based study allowed us to observe the role of different risk factors, as well as the effect of colonization at multiple sites, on the incidence of infection within each household over time.

Community reservoirs of CA-MRSA are not well defined. Previous investigations have noted that CA-MRSA may “ping-pong” among family members, and high rates of nasal colonization among children suggest that they are often instrumental in transmitting infection within households [21–23]. Our study suggests that colonization of the genital area and

heterosexual activity among adult members of an infected household may also lead to recurrent infection within households and may turn individual households into major potential reservoirs of infection for the rest of the community.

Acknowledgments

We gratefully acknowledge Abigail Zuger and J. Todd Weber for their helpful suggestions regarding this article.

Financial support. Centers for Disease Control and Prevention (CCR223380-01) and the National Center for Research Resources, National Institutes of Health, which supports the Center for Interdisciplinary Research on Antimicrobial Resistance (P20 RR020616 to E.L. and F.D.L.).

Potential conflicts of interest. All authors: no conflicts.

References

- Centers for Disease Control and Prevention. Four pediatric deaths from community-acquired methicillin-resistant *Staphylococcus aureus*—Minnesota and North Dakota, 1997–1999. *JAMA* **1999**;282:1123–5.
- Herold BC, Immergluck LC, Maranan MC, et al. Community-acquired methicillin-resistant *Staphylococcus aureus* in children with no identified predisposing risk. *JAMA* **1998**;279:593–8.
- Naimi TS, LeDell KH, Boxrud DJ, et al. Epidemiology and clonality of community-acquired methicillin-resistant *Staphylococcus aureus* in Minnesota, 1996–1998. *Clin Infect Dis* **2001**;33:990–6.
- Kazakova SV, Hageman JC, Matava M, et al. A clone of methicillin-resistant *Staphylococcus aureus* among professional football players. *N Engl J Med* **2005**;352:468–75.
- Ellis MW, Hospenthal DR, Dooley DP, Gray PJ, Murray CK. Natural history of community-acquired methicillin-resistant *Staphylococcus aureus* colonization and infection in soldiers. *Clin Infect Dis* **2004**;39:971–9.
- Charlebois ED, Bangsberg DR, Moss NJ, et al. Population-based community prevalence of methicillin-resistant *Staphylococcus aureus* in the urban poor of San Francisco. *Clin Infect Dis* **2002**;34:425–33.
- Pan ES, Diep BA, Charlebois ED, et al. Population dynamics of nasal strains of methicillin-resistant *Staphylococcus aureus*—and their relation to community-associated disease activity. *J Infect Dis* **2005**;192:811–8.
- Turabelidze G, Lin M, Wolkoff B, Dodson D, Gladbach S, Zhu BP. Personal hygiene and methicillin-resistant *Staphylococcus aureus* infection. *Emerg Infect Dis* **2006**;12:422–7.
- Oliveira DC, de Lencastre H. Multiplex PCR strategy for rapid identification of structural types and variants of the *mec* element in methicillin-resistant *Staphylococcus aureus*. *Antimicrob Agents Chemother* **2002**;46:2155–61.
- Okuma K, Iwakawa K, Turnidge JD, et al. Dissemination of new methicillin-resistant *Staphylococcus aureus* clones in the community. *J Clin Microbiol* **2002**;40:4289–94.
- Cespedes C, Said-Salim B, Miller M, et al. The clonality of *Staphylococcus aureus* nasal carriage. *J Infect Dis* **2005**;191:444–52.
- Tenover FC, Arbeit RD, Goering RV, et al. Interpreting chromosomal DNA restriction patterns produced by pulsed-field gel electrophoresis: criteria for bacterial strain typing. *J Clin Microbiol* **1995**;33:2233–9.
- Kaneko J, Muramoto K, Kamio Y. Gene of LukF-PV-like component of Panton-Valentine leukocidin in *Staphylococcus aureus* P83 is linked with lukM. *Biosci Biotechnol Biochem* **1997**;61:541–4.
- Tenover FC, McDougal LK, Goering RV, et al. Characterization of a strain of community-associated methicillin-resistant *Staphylococcus aureus* widely disseminated in the United States. *J Clin Microbiol* **2006**;44:108–18.
- Naimi TS, LeDell KH, Como-Sabetti K, et al. Comparison of community- and health care-associated methicillin-resistant *Staphylococcus aureus* infection. *JAMA* **2003**;290:2976–84.
- Lee NE, Taylor MM, Bancroft E, et al. Risk factors for community-associated methicillin-resistant *Staphylococcus aureus* skin infections among HIV-positive men who have sex with men. *Clin Infect Dis* **2005**;40:1529–34.
- Moellering RC Jr. The growing menace of community-acquired methicillin-resistant *Staphylococcus aureus*. *Ann Intern Med* **2006**;144:368–70.
- von Eiff C, Becker K, Machka K, Stammer H, Peters G. Nasal carriage as a source of *Staphylococcus aureus* bacteremia. Study Group. *N Engl J Med* **2001**;344:11–6.
- Kuehnert MJ, Kruszon-Moran D, Hill HA, et al. Prevalence of *Staphylococcus aureus* nasal colonization in the United States, 2001–2002. *J Infect Dis* **2006**;193:172–9.
- Graham PL 3rd, Lin SX, Larson EL. A US population-based survey of *Staphylococcus aureus* colonization. *Ann Intern Med* **2006**;144:318–25.
- Jones TF, Creech CB, Erwin P, Baird SG, Woron AM, Schaffner W. Family outbreaks of invasive community-associated methicillin-resistant *Staphylococcus aureus* infection. *Clin Infect Dis* **2006**;42:e76–8.
- Creech CB 2nd, Talbot TR, Schaffner W. Community-associated methicillin-resistant *Staphylococcus aureus*: the way to the wound is through the nose. *J Infect Dis* **2006**;193:169–71.
- Huang YC, Su LH, Chen CJ, Lin TY. Nasal carriage of methicillin-resistant *Staphylococcus aureus* in school children without identifiable risk factors in northern Taiwan. *Pediatr Infect Dis J* **2005**;24:276–8.