Methicillin-Resistant Staphylococcus aureus in Two Child Care Centers

Penny M. Adcock,* Patricia Pastor, Francinne Medley, Jan E. Patterson, and Trudy V. Murphy

Methicillin-resistant Staphylococcus aureus (MRSA) has not been studied in child care centers. The prevalence of MRSA colonization was determined at two centers with an index patient. Two (3%) of 61 children at center X had MRSA; strains from both children and the index illness were pulsed-field gel electrophoresis type B. Nine (24%) of 40 children at center Y had MRSA; strains from 5 children and the index illness were type B, and strains from 4 children were type A. Ten of 11 colonized children were in classes with 2- and 3-year-old children. Colonization with MRSA was not associated with health care contact by subjects or by members of their households. MRSA in child day care centers indicates accelerated spread of MRSA in the community.

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Written, informed consent was obtained from parents or legal guardians of children participating in the study. The clinical research was conducted in accordance with the guidelines established by and was approved by the Institutional Review Board, University of Texas Southwestern Medical Center at Dallas. 

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were obtained at the center. Anterior nares cultures from family members were negative for MRSA during the index patient’s illness. The patient and 1 sibling were treated empirically with intranasal mupirocin before returning to the center. The patient was previously healthy; 1 parent was a health care worker.

Center Y was a nonprofit facility affiliated with a church; the director had operated the center for 4 years. Center X was a nonprofit facility that the director had owned and operated for 18 years. The centers were located in different parts of Dallas and did not share personnel. Other characteristics were similar (table 1).

At center Y, children were divided into five classes by age: infant (7–16 months), toddler (18–31 months), older toddler (26–54 months), preschool (36–62 months), and children attending before and after school (4–10 years). The toddler, older toddler, and preschool classes shared a room for 2 h in the morning and dining and outdoor play areas. Approximately 20% of children, including the index patient and a member of each class, were transported in a van to and from home.

At center X, children were divided into four classes by age: infant (4–14 months), toddler (19–36 months), preschool (36–60 months), and children attending before and after school (5–11 years). Toddler and preschool classes shared dining and outdoor play areas.

**Cultures and questionnaire.** A culture of the anterior nare and of the axilla was obtained from each child and child care provider. Most cultures were taken on a single visit to each center (June 1996); remaining cultures were collected within 1 month. Parents and child care providers completed a questionnaire about factors previously associated with MRSA. Information was requested about all household members who had been patients or had contact with patients in a hospital, nursing home, or other health care facilities. Visits to doctors’ offices or clinics for primary health care were excluded. Because MRSA colonization has been reported to persist for up to a median of 20 months [5], health care contact arbitrarily was defined as potentially significant for acquisition of MRSA if it occurred within 2 years before the study.

**Laboratory methods.** Cultures of the anterior nare and axilla were collected with separate sterile Dacron swabs moistened with trypticase soy broth (BBL Microbiologic Systems, Cockeysville, MD). Both swabs from a child were transported to the laboratory in a single tube of the broth. After incubation overnight at 35°C [5], 0.01 mL of the broth was inoculated onto Staph 110 agar containing 6 μg/mL oxacillin (Remel, Lenexa, KS) and streaked to isolate colonies. American Type Culture Collection MRSA 33591 served as a positive control; *S. aureus* 29213 served as an oxacillin-susceptible negative control. Isolates were confirmed to be *S. aureus* using the catalase test (Spot Test; Difco, Detroit) and the coagulase slide and tube tests (Remel Coagulase Plasma). *S. aureus* isolates were inoculated onto Mueller-Hinton agar (Remel) containing 6 μg/mL of oxacillin and 4% NaCl in accordance with the National Committee for Clinical Laboratory Services guidelines. Growth on this medium confirmed resistance to methicillin [6]. Susceptibility of MRSA to other antimicrobial agents was determined using the Dade Microscan dried gram-positive panel (Dade International, West Sacramento, CA).

Isolates from the index patients and children who were colonized were typed by pulsed-field gel electrophoresis of whole cell DNA according to the method of Layton et al. [7]. Isolates were considered identical if the number and molecular size of all bands matched, and related if they differed by three or fewer bands. Isolates were considered distinct if the pulsed-field gel electrophoresis pattern differed by more than three bands [8].

**Statistical analysis.** The *χ²* or Fisher’s exact test was used for comparison of categoric variables, and the Mann-Whitney test was used for comparison of continuous variables. *P = .05* defined statistical significance for tests of two-tailed hypotheses.

**Results**

Cultures were obtained from 38 of 40 children and 2 of 5 child care providers at center Y and from all 61 children and 7 child care providers at center X. Eleven children were colonized with MRSA, 9 (24%) at center Y and 2 (3%) at center X. No child care provider was colonized. All isolates had similar antibiograms: resistant to oxacillin (MIC > 4 μg/mL) and susceptible to gentamicin, clindamycin, rifampin, trimethoprim-sulfamethoxazole, and vancomycin.

At center Y, 2 strains of MRSA were isolated; isolates from the index case and 5 of 9 colonized children were type B, isolates from 3 colonized children were type A, and the isolate from 1 colonized child was a related strain, type A1. Children colonized with MRSA were younger than children who were not colonized (median age, 26 months vs. 43 months, *P = .008*).

At center X, isolates from the index illness and both colonized children were type B. The ages of the children colonized with MRSA were 38 and 64 months compared with a median age of 48 months for the 59 children who were not colonized. Subjects with MRSA were clustered in classes of 2- and 3-year-old children (table 2). At center Y, all children colonized with strain B were assigned to the toddler and older toddler classes. The siblings of the index patient were in these classes. Three of 4 children colonized with strain A were also in the toddler and preschool classes, which were combined for several hours each day. Six subjects with MRSA were sibling pairs, 2 pairs with strain B and 1 pair with strain A. At center X, the 2 children with MRSA were unrelated. They were assigned with the index patient and sibling to classes with 2- and 3-year-old children. All children in the study who were colonized with MRSA were healthy.

**Table 1. Characteristics of the day care centers and enrollees.**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Center Y</th>
<th>Center X</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. enrolled</td>
<td>40</td>
<td>61</td>
</tr>
<tr>
<td>No. of classes</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>No. of child care providers</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Child-to-staff ratios</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infants</td>
<td>3:1</td>
<td>4.5:1</td>
</tr>
<tr>
<td>Toddlers</td>
<td>10:1</td>
<td>12:1</td>
</tr>
<tr>
<td>Age range (months)</td>
<td>7–110</td>
<td>4–136</td>
</tr>
<tr>
<td>Median time enrolled at center (months)</td>
<td>15.4</td>
<td>20.0</td>
</tr>
</tbody>
</table>
Table 2. Colonization with MRSA at center Y by DNA strain type and classroom assignment.

<table>
<thead>
<tr>
<th>Class (n)</th>
<th>DNA strain type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
</tr>
<tr>
<td>Infant (3)</td>
<td>0*</td>
</tr>
<tr>
<td>Toddler (8)</td>
<td>3†</td>
</tr>
<tr>
<td>Older toddler (11)</td>
<td>2§</td>
</tr>
<tr>
<td>Preschool (13)</td>
<td>0</td>
</tr>
<tr>
<td>School (5)</td>
<td>0</td>
</tr>
</tbody>
</table>

NOTE. See text for data on center X.
* Index patient group assignment; strain B isolated from index illness.
† Sibling in older toddler group.
§ Two of 3 colonized children were siblings (twins).

In 59 (60%) of 99 children, a child or household member had contact with a health care facility within 2 years before the study. Health care contact was not associated with MRSA for children at either center or for the combined sample.

Discussion

This study was the first to examine MRSA in child day care centers. The most significant finding was the overall prevalence of colonization with MRSA: 24% and 3% of children attending centers Y and X, respectively. These rates are similar to those found at long-term care facilities and drug rehabilitation centers (8%–23%) previously identified as community reservoirs of MRSA [3, 9, 10]. Although we investigated only two centers and the results should not be generalized, our findings raise the possibility that MRSA has become a community pathogen, with transmission in child day care centers.

The evidence for transmission of MRSA at the centers was clustering of subjects colonized with the same MRSA strain in classes with 2- and 3-year-old children. Children of this age effectively transmit bacterial respiratory agents to classmates, siblings, and household members because they normally have repeated person-to-person contact [4]. In hospitals, MRSA is spread by transiently colonized hands of caretakers [11]. It is also disseminated efficiently in aerosols from infants and adults with upper respiratory infections [12]. Since children attending day care centers have increased rates of respiratory infections [4], this setting is likely to be conducive to the spread of MRSA.

It has been argued that spread of MRSA in the community originates with patients discharged from hospitals or nursing homes [2, 9]. Similarly, we initially thought that MRSA at the study centers originated with children or others in their households who acquired MRSA at health care facilities. Colonization with MRSA can persist for months [5], and transmission between household members is well described [13]. Although many households in our study had a person with health care contact meeting our definition, our results failed to identify an association with MRSA colonization in the children. An association could have been masked by the small sample size (type II error) or by our definition of health care contact if too inclusive.

We speculated that child care centers may increasingly be a reservoir of MRSA. Children in day care centers receive two to three times more courses of oral antibiotics than children who stay at home; this frequent use of antibiotics has been linked to sustaining populations of resistant bacteria [4]. Selection of MRSA has been suspected in other community settings with heavy use of antibiotics. In 1980, an outbreak of gentamicin-susceptible MRSA in intravenous drug users with endocarditis was attributed to repeated use of oral cephalosporins [3]. In 1989, investigators proposed that a new clone of MRSA in Western Australia emerged as a result of frequent use of antibiotics in the community [14]. The antibiogram of these and other recently described community-acquired isolates was similar to that of our isolates and distinct from the multiply resistant MRSA described a decade ago [11, 14, 15].

Infections caused by S. aureus result in significant morbidity and mortality in normal and debilitated adults and children [2]. We found >1 strain of MRSA colonizing unrelated, healthy children at geographically separated day care centers. Our results provide additional evidence that MRSA may have become established in the community, as was observed with penicillin-resistant S. aureus in the 1950s [1]. Epidemiologic studies of MRSA in the community are needed to determine the scope of this emerging problem.

Acknowledgments

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References

Selective Increase in Plasma Tumor Necrosis Factor-α and Concomitant Clinical Deterioration after Initiating Therapy in Patients with Severe Tuberculosis

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The initiation of antituberculosis treatment in patients with severe tuberculosis may be accompanied by clinical deterioration and even death before any improvement occurs. To investigate this phenomenon, newly diagnosed human immunodeficiency virus–negative adults with severe tuberculosis were followed for the first 42 days of standard short-course therapy. Clinical status, serum lactate, plasma cytokine, and plasma cytokine receptor levels were monitored on days 0, 3, and 7 and then weekly for up to 42 days. Following 7 days of antituberculosis therapy, a significant transient decrease in mean Karnofsky score (P < .001), a concomitant increase in serum lactate (P = .06), a decrease in patient weight (P = .02), and an increase in plasma tumor necrosis factor-α (TNF-α) concentrations (P = .04) were observed. Plasma levels of soluble interleukin-2 receptor, interferon-γ, interleukin-6, and TNF-α receptor decreased over the 42-day study period. These observations suggest that increases in plasma TNF-α levels may be associated with clinical deterioration observed early in the treatment of severe tuberculosis.

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Written informed consent was obtained from all patients. The study was approved by the Ethics Committee of the University of Cape Town, South Africa, and the Institutional Review Board of Rockefeller University, New York.

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0222–1899/98/7802–0043$02.00 were associated with changes in levels of these proteins.