Eradication of Methicillin-Resistant
Staphylococcus aureus From a Health Center
Ward and Associated Nursing Home

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Background: Long-term health care facilities have been recognized as reservoirs of multiresistant bacterial strains, especially methicillin-resistant Staphylococcus aureus (MRSA). Efforts to control MRSA in this setting usually have been only partially effective. We describe herein the eradication of epidemic MRSA from a Finnish health care center ward and affiliated nursing home.

Methods: The methods to control MRSA included (1) contact isolation precautions, (2) screening for asymptomatic carriage, (3) eradication of carriage, and (4) education of staff on hygienic measures. The first 6 patients with MRSA-positive findings were referred without delay to the Infectious Diseases Unit of the adjacent university hospital for eradication treatment. Later, an isolation unit of 6 rooms was founded in the health care center, where the MRSA-colonized patients were nursed as a separate cohort until they, in succession, were referred to the Infectious Diseases Unit for decolonization.

Results: From May 20 through August 17, 1993, the epidemic MRSA strain was isolated from 8 long-term patients on the 40-bed ward of the health care center, 4 of the 59 residents of the nursing home, and 1 member of the staff. Eradication of carriage was successful in all except 1 patient with dementia, who was nursed in contact isolation in the health care center until his death 21 months later.

Conclusions: It is possible to eradicate MRSA from a long-term health care facility even after 13 cases by applying strict control measures. Our experience may be valuable in the future decision-making process for control of new and more challenging multiresistant bacteria, eg, vancomycin-resistant strains of MRSA.

Arch Intern Med. 2001;161:859-863

RESULTS

OUTBREAK AND CONTROL MEASURES

From the end of May 20 through the August 17, 1993, the epidemic MRSA strain was isolated from 8 long-term patients on the ward of 40 beds in the MHC, 4 of the 59 residents of the nursing home, and 1 member of the staff. From the index pa-
PATIENTS AND METHODS

INSTITUTIONS

The MHC has 40 beds, mainly for elderly or geriatric patients with multiple underlying diseases. The nursing home for the elderly has 39 beds and is situated in the same building. Patients are often referred from the nursing home to the MHC ward and vice versa.

The Turku University Central Hospital is a 1100-bed teaching facility serving as a tertiary referral center for the southwestern part of the country (Southwest Finland Medical District). At the time of the outbreak, the Department of Infectious Diseases of that hospital had 16 beds.

MICROBIOLOGICAL TECHNIQUES

Screening and Follow-up Cultures

Initial screening for MRSA involved nasal, throat, and perineal swabbing and cultures from all open wounds and skin lesions. If a patient was identified as a carrier, the extent of MRSA colonization was determined by taking further samples from the groin, axillae, urethra, and feces. The cultures were taken by means of rotating a premoistened cotton swab around the sampling site, and the specimens were streaked directly on mannitol salt agar plates containing 1-ug/mL oxacillin.

A patient was usually deemed to be clear of MRSA when 3 sets of screening swabs with negative findings were obtained after decolonization treatment. However, colonization cultures were continued to verify persistent eradication of MRSA. The schedule of the cultures taken was as follows: until the end of 1993, cultures were taken from each patient twice or 4 times a month; during 1994, once or twice a month; and from 1995 onward, twice a year.

Identification of the Epidemic MRSA Strain

After incubating the plates at 35°C for 48 hours, they were evaluated for the presence of growth and colonies were identified using standard procedures. The isolates collected from the plates were identified as MRSA following the guidelines recommended by the National Committee for Clinical Laboratory Standards. Based on disk diffusion and minimal inhibitory concentration determined by the E test, the epidemic MRSA strain was resistant to methicillin (minimal inhibitory concentration of oxacillin, > 256 μg/mL) and possessed the mecA gene. When typed using the International Phage Set, the strain belonged to the phage type 54, 84, 85III/96V/95 (100 × routine test dilution).

ERADICATION TREATMENT

Eradication courses involved topical treatment alone or combined with systemic antimicrobial therapy. In addition, all patients used an antiseptic detergent containing 4% chlorhexidine gluconate in daily washing or bathing. Topical treatment consisted of the application of a cream containing 2% mupirocin calcium 3 times a day locally at the colonized body sites for 3 to 7 days. The patients in whom colonization affected deeper sites (especially the throat), where local treatment could not be administered, also received systemic treatment. The antimicrobial agents used as systemic therapy were selected based on in vitro susceptibility of the epidemic MRSA strain. A patient was given simultaneously 2 different antimicrobial agents to which the colonizing organism was susceptible, usually for 2 weeks. Two patients had their dentures sterilized with heat simultaneous with the eradication treatment, with the aim to prevent recolonization originating from contaminated foreign material.

(Illustration: Figure indicating MRSA eradication process)

In the middle of June, MRSA was isolated from 4 female MHC patients, of whom 2 were roommates. The total number of patients with positive findings for MRSA was now so large that the Department of Infectious Diseases could not accommodate all new patients immediately. Thus, in the third week of June, a separate unit of 6 rooms (6-10 beds total) was opened in the MHC, where the MRSA-colonized patients were nursed by an assigned staff in contact isolation until they could be admitted to the Department of Infectious Diseases for decolonization. The isolation unit was established in a separate wing of the hospital building, which had its own exit.

The staff assigned to work in the isolation unit was further trained by the University Hospital Infection Control Team on nursing patients in contact isolation, with special emphasis on the nature of MRSA as a pathogen and on its modes of transmission. During an educational visit, each staff member was given an opportunity to observe the daily routine in the Department of Infectious Diseases, thus becoming better acquainted with infection control measures. During the first months of the outbreak, the isolation unit staff did not participate in the care of other patients of the ward.

Patient (patient 1), MRSA was isolated from a clinical specimen. The clinical microbiology laboratory informed the University Hospital Infection Control Team of the MRSA finding and a consultation was given. The patient was immediately referred to the Department of Infectious Diseases, Turku University Central Hospital, to be nursed in contact isolation, since no satisfactory isolation facilities or previous experience with MRSA were available in the MHC. Initial MRSA screening on the ward was limited to those patients who had been in close contact with the index patient, ie, shared a room with her.

At the beginning of June, MRSA was isolated from 2 previous roommates of the index patient. At this point, the University Hospital Infection Control Team visited the MHC to delineate appropriate control measures for the containment of MRSA. All patients of the ward were advised to undergo screening for MRSA. Moreover, all MHC staff were given further education on hospital hygiene. Special attention was focused on vigorous promotion of hand disinfection, which was deemed necessary after every patient contact, and on appropriate use of barriers in nursing.

A few days later, MRSA was isolated from a traumatic forehead wound of a resident of the nursing home. This patient also had previously shared a room on the MHC ward with the index patient. Soon thereafter, 2 male patients sharing a room on the ward were shown to be MRSA carriers. A decision was then made to screen the residents of the nursing home for MRSA.

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After establishment of the isolation unit, further screening of contact patients on the ward and in the nursing home revealed MRSA in 2, the first in the end of June and the second (patient 12) in the middle of August 1993.

COLONIZED PATIENTS AND ERADICATION OF MRSA

Characteristics of the MRSA-positive patients and the quality and outcome of eradication treatment are presented in Table 1. The sites of MRSA colonization are described in Table 2.

Table 1. Characteristics of 12 Patients With Methicillin-Resistant Staphylococcus aureus*

<table>
<thead>
<tr>
<th>Patient No./ Sex/Age, y</th>
<th>Underlying Disease</th>
<th>Open Wounds/Skin Diseases</th>
<th>Institution†</th>
<th>Eradication Courses (No. Given)</th>
<th>Outcome of Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/F/87</td>
<td>Hemiplegia, heart insufficiency</td>
<td>Suppurative tuberculous lymphadenitis</td>
<td>MHC ‡ ‡</td>
<td>Failure</td>
<td>Failure</td>
</tr>
<tr>
<td>2/F/80</td>
<td>Diabetes mellitus, coronary disease</td>
<td>Severe psoriasis</td>
<td>MHC A§</td>
<td>Successful</td>
<td>Successful</td>
</tr>
<tr>
<td>3/F/88</td>
<td>Nasopharyngeal cancer, chronic pyelonephritis</td>
<td>Wound in the nostril</td>
<td>MHC A§</td>
<td>Successful</td>
<td>Successful</td>
</tr>
<tr>
<td>4/F/84</td>
<td>Senility, multiple brain infarcts, diabetes mellitus</td>
<td>Wound in the forehead, leg sore</td>
<td>NH B</td>
<td>Successful</td>
<td>Successful</td>
</tr>
<tr>
<td>5/M/70</td>
<td>Senility, multiple brain infarcts, diabetes mellitus</td>
<td>None</td>
<td>MHC A (3)</td>
<td>Failure</td>
<td>Failure</td>
</tr>
<tr>
<td>6/M/78</td>
<td>Parkinson disease, heart insufficiency, coronary disease</td>
<td>Wounds in the hands</td>
<td>MHC A</td>
<td>Successful</td>
<td>Successful</td>
</tr>
<tr>
<td>7/F/78</td>
<td>Senility, coronary disease</td>
<td>Pemphigoid, bed sores</td>
<td>MHC</td>
<td>A</td>
<td>Successful</td>
</tr>
<tr>
<td>8/F/95</td>
<td>Senility, osteitis of the foot</td>
<td>Wound in the foot</td>
<td>MHC</td>
<td>A</td>
<td>Successful</td>
</tr>
<tr>
<td>9/F/80</td>
<td>Apoplectic, heart insufficiency, ulcerative colitis</td>
<td>Wound in the side</td>
<td>MHC</td>
<td>A (2)</td>
<td>Successful</td>
</tr>
<tr>
<td>10/F/90</td>
<td>Senility, chronic pyelonephritis</td>
<td>Wound in the leg</td>
<td>MHC</td>
<td>B</td>
<td>Successful</td>
</tr>
<tr>
<td>11/F/88</td>
<td>Heart insufficiency, hypothyroid disease, pernicious anemia</td>
<td>None</td>
<td>NH</td>
<td>A (2)</td>
<td>Successful</td>
</tr>
<tr>
<td>12/F/80</td>
<td>Senility</td>
<td>None</td>
<td>NH</td>
<td>A</td>
<td>Successful</td>
</tr>
</tbody>
</table>

*MRSA indicates methicillin-resistant S aureus; MHC, Mynamaki Health Center; NH, nursing home; A, a course of combined local and systemic eradication treatment; and B, a course of local eradication treatment.
†Indicates the institution in which the patient was treated at the time of the first positive MRSA culture.
‡The patient received antituberculous therapy during which findings of MRSA cultures remained negative until her death. In addition, therefore, the outcome cannot be assessed.
§The dentures of the patient were sterilized with heat simultaneous with the eradication course.

Table 2. Distribution of the Methicillin-Resistant Staphylococcus aureus Carriage at Various Body Sites Before First Eradication Treatment*

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Nares</th>
<th>Throat</th>
<th>Perineum</th>
<th>Groin</th>
<th>Axillae</th>
<th>Wound</th>
<th>Urine</th>
<th>Feces</th>
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</thead>
<tbody>
<tr>
<td>1†</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>+</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>2</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<td>+</td>
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<td>+</td>
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<td>+</td>
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<td>+</td>
<td>+</td>
</tr>
<tr>
<td>4</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>+‡</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>5</td>
<td>+</td>
<td>+</td>
<td>−</td>
<td>−</td>
<td>+</td>
<td>No wound</td>
<td>+</td>
<td>−</td>
</tr>
<tr>
<td>6</td>
<td>−</td>
<td>+</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>7</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>ND</td>
<td>+</td>
<td>+</td>
<td>ND</td>
<td>−</td>
</tr>
<tr>
<td>8</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>−</td>
<td>+</td>
<td>+</td>
<td>ND</td>
<td>−</td>
</tr>
<tr>
<td>9</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>−</td>
<td>+</td>
</tr>
<tr>
<td>10</td>
<td>−</td>
<td>+</td>
<td>−</td>
<td>ND</td>
<td>−</td>
<td>−</td>
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<td>−</td>
</tr>
<tr>
<td>11</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>ND</td>
<td>No wound</td>
<td>+</td>
<td>+</td>
<td>−</td>
</tr>
<tr>
<td>12</td>
<td>−</td>
<td>−</td>
<td>+</td>
<td>−</td>
<td>ND</td>
<td>No wound</td>
<td>−</td>
<td>−</td>
</tr>
</tbody>
</table>

*All patients were long-term carriers based on positive findings in at least 2 successive cultures. Plus sign indicates positive; minus sign, negative (detected as described in the text); and ND, cultures from that body site were not taken.
†Before commencement of antituberculous therapy for tuberculous lymphadenitis.
‡Methicillin-resistant S aureus culture findings from the wound of the forehead were positive; from the leg sore, negative.

After establishment of the isolation unit, further screening of contact patients on the ward and in the nursing home revealed MRSA in 2, the first in the end of June and the second (patient 12) in the middle of August 1993.

Two patients with mucosal or wound colonization received topical treatment with mupirocin, whereas 9 patients who were throat carriers were administered a combination of topical and systemic treatment. The most commonly used systemic antimicrobial agent was clindamycin hydrochloride (given on 11 occasions), followed by rifampin, fluoroquinolone (ciprofloxacin hydrochloride or ofloxacin), and fusidic acid. More detailed data on drug regimens will be reported separately (P.K., R.P., and T.R., unpublished data, December 2000). Eradication was successful in 10 patients. Despite 3 courses of local and systemic treatment, MRSA grew...
in cultures from patient 5 until his death 21 months later. The outcome cannot be assessed in the index patient in whom findings for MRSA became negative during antituberculous treatment (active also against MRSA), which was continued until her death 5 months later. Of these 12 patients, 1 died in 1993, 2 in 1994, 3 in 1995, 3 in 1996, and 2 in 1997. One patient is still alive.

CULTURES FROM THE STAFF AND CONTACT PATIENTS

Before establishing the isolation unit, the 89-member staff of the MHC underwent screening for MRSA once by means of nasal swabs, with negative findings. Subsequently, the 12-member staff working in the isolation unit underwent screening once a month by means of nasal swabs. Transient carriage of MRSA was detected in 1 nurse, with positive findings in 1 nasal culture.

After identification of the last positive case, all patients of the ward and residents of the nursing home underwent screening for MRSA 2 to 4 times with negative findings. During the first 4 months after the beginning of the outbreak, altogether 727 colonization cultures were taken in the MHC. Afterward, colonization cultures were taken only from the patients with previous findings positive for MRSA.

END OF THE OUTBREAK

For the decolonized patients, contact isolation measures were mainly stopped by the end of 1993. However, the importance of adherence to a strict hand-washing and/or disinfection routine after every patient contact was reinforced repeatedly to the staff. The University Hospital Infection Control Team visited the MHC 5 times during the outbreak. The decolonized patients continued to occupy their rooms in the previous isolation wing, but over the years, new patients were accommodated there. For the 1 patient with continued positive findings for MRSA, contact isolation precautions were continued until his death in March 1995. This was feasible because he was bedridden and, due to dementia caused by multiple brain infarcts, unaware of the world around him.

**COMMENT**

Eradication of an epidemic MRSA strain from a Finnish long-term health care facility succeeded by means of combined efforts of the local health center personnel and the University Hospital Infection Control Team. We assume that implementation of even the strictest control measures would have been in vain without the devotion of the health care providers to bring this project to a favorable end. The solidarity of the local health center personnel, including the financial decision makers, was an indispensable strength of this endeavor, bearing in mind that at the time of the outbreak there were no generally accepted rules in Finland on how to control an MRSA outbreak in a long-term health care facility. On the other hand, all available data were from countries with a highly different epidemiological situation and, as such, not readily applicable in an environment practically devoid of MRSA.

The initial decision to screen only a few close contacts of the index patient concurred with the concept that the risk for the spread of MRSA in a long-term health care setting is small and clinical infections are rare.\(^{2}\) This has been shown by Bradley et al,\(^{16}\) who studied MRSA colonization, transmission, and infection for 1 year in a facility with endemic MRSA and found that 10% of newly admitted patients acquired MRSA while in the facility but that the rate of infection was low. From that and similar studies,\(^{37}\) the flexible MRSA control policy currently advised for long-term health care facilities seems justified. The mainstays of this strategy in many countries with a high prevalence of MRSA include stringent hand-washing and hand-disinfection routines and surveillance of clinical infections, whereas MRSA screening, decolonization efforts, and isolation precautions are discouraged.\(^{9}\) It is obvious that a more stringent policy is unwarranted in facilities where a large number of long-term patients harbor MRSA. It is equally obvious that in any extended health care setting, enforcement of strict control measures (eg, patient isolation) for long periods would be too disruptive and unrealistic.

However, in a facility with no previous MRSA, an active policy when a new case is identified could be rewarding. This has been suggested also by Simor et al,\(^{18}\) who managed to eradicate a defined MRSA strain from a long-term health care facility in Canada after identification of 5 cases. These authors underscored that chances of effective control of MRSA are increased if infection control interventions are implemented early, before the organism becomes endemic. Besides that report and the present one, we are not aware of any other reports on eradication of an epidemic MRSA strain that has spread to several patients in an extended health care facility. In fact, the efforts to control MRSA in a long-term health care setting have usually been only partially effective.\(^{10,21}\)

The benefits of eradication of MRSA from an extended health care facility are supported by the finding of Muder et al\(^{22}\) that colonization may be predictive of infection: in patients treated in a long-term Veterans Affairs medical center, colonization by MRSA indicated a significantly greater risk for infection than did colonization by methicillin-susceptible S. aureus (25% vs 4%; \(P < .01\)). According to Boyce et al,\(^{7}\) about 5% to 10% of residents who acquire MRSA in long-term health care facilities will eventually become infected. Thus, when it was obvious that MRSA was spreading in the MHC, the intention of the local health authorities to prevent infection was an indication to encourage a stringent eradication policy.

At present, the Nordic countries are among the very few in the world in which MRSA strains are still uncommon.\(^{3,6}\) These countries are characterized by implementation of national guidelines for the control of multiresistant staphylococcal strains. In Finland, national guidelines for MRSA were issued in 1995.\(^{6}\) The cornerstones of our control policy involve screening of all patients who have been previously treated in hospitals abroad or with a known MRSA problem at the time of admission to a Finnish hospital, and nursing these patients, and all patients known to have positive findings for MRSA, in private rooms using contact isolation precautions until colonization cultures have proved to be negative. In the Turku University Central Hospital area, a similarly
strict policy was adopted after containment of the 1991-1992 MRSA epidemic. Consequently, had MRSA spread and become endemic in the MHC, screening and contact isolation precautions would have been instituted on all future patients referred from this facility to other hospitals in southwest Finland. This option was evidently seen by the MHC leaders as another strong point to favor aggressive eradication efforts.

The University Hospital Infection Control Team also had other concerns. In many countries, nursing and residential homes with endemic MRSA have been responsible for spreading this microorganism into neighboring hospitals. On this basis, the potential development of an MRSA reservoir in one of our health care centers was estimated to jeopardize severely the previously stable epidemiological situation in the entire area. The control of multiresistant microorganisms in our medical district was already supervised by the University Hospital Infection Control Team. This guaranteed, at least to some extent, compliance with a stringent MRSA policy also in the surroundings of Myy纳米. Because of our mutual interest to keep the MRSA incidence low in this region, we believe that our goal to eradicate MRSA from the MHC was reasonable. Then again, such a decision would have been unwise had there not been a conviction that a comparable policy was followed in the neighboring hospitals. The prudent nature of this operation in the Southwest Finland Medical District is supported by the continuously excellent MRSA situation 7 years later: we did not detect any intrahospital transmission of MRSA during the past year.

At present, a stringent policy aimed at searching for MRSA-colonized patients and eradication of carriage may be reasonable and feasible in a few countries only. However, the value of the present report lies in the description of successful control of any epidemic multiresistant strain, not specifically MRSA. It is important to remember that although the battle against MRSA appears to be lost in many countries, there may be new and more challenging strains of S. aureus to come. To successfully gain control of future multiresistant strains, one should learn from earlier failures and accomplishments.

CONCLUSIONS

Eradication of MRSA from a health care center ward and associated nursing home succeeded by following a stringent control policy. We believe that for MRSA, such a policy may be reasonable in an environment with no endemic strains. An educated and motivated staff smoothly cooperating with the University Hospital Infection Control Team, ardent support from the health care center leadership, and a uniform policy for the control of multiresistant strains in the medical district were the strengths of the endeavor. Our experience may be valuable in the future decision-making process for control of emerging multiresistant bacteria, eg, vancomycin-resistant strains of MRSA.

Accepted for publication October 23, 2000.

This work was supported by a grant from the EVO Foundation of the Turku University Central Hospital, Turku, Finland.

We thank Kirsti Tuomela, Ritva Scotford, and Elina Siren for expert technical assistance.

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