METHICILLIN-RESISTANT *STAPHYLOCOCCUS AUREUS* OUTBREAK IN A BURN UNIT: THE EMERGENCE OF A RARE MRSA CLONE LOS ANGELES COUNTY, 2005

BACKGROUND

Methicillin-resistant S*taphylococcus aureus* (MRSA) has emerged as a major cause of hospital morbidity and mortality throughout the world [1–3] and is now one of the most common infections acquired in the hospital setting. Hospital specialty units—such as the intensive care unit (ICU), neonatal ICU, and burn and transplant services—care for patients who are medically fragile, frequently immunocompromised and at increased risk for nosocomial MRSA infection. Burn patients, without the skin's protective barrier over large body surfaces, are particularly susceptible to nosocomial MRSA infection. Additional risk factors for nosocomial MRSA acquisition include antibiotic use and length of hospital stay [4].

On October 3, 2005, the ACDC was informed of 7 patients with MRSA infections in the burn unit of an acute care hospital in LAC. At the time of the call, the census in the burn unit was 15. Five of the initial infections occurred within an eight-day period at the end of September; one each occurred in August and the middle of September. Prior to August 2005, there had only been 4 MRSA cultures from patients in this unit during 2005. ACDC initiated an investigation to determine the source of the infections and to develop control measures.

METHODS

Setting: The burn unit is housed in a separate building attached by hallways to the main hospital building. The unit is licensed for 30 beds, though only 15-20 are generally in use. Locked double doors restrict public access to the unit, which houses both adult and pediatric patients. In addition to in-patient services, same day surgical services and outpatient clinic services are also provided.

Case Definition: A case was defined as an in-patient or out-patient of the burn unit during the outbreak period (August 22, 2005 to November 24, 2005) who had culture-confirmed MRSA isolate identical to the predominant outbreak clone ether by pulsed-field gel electrophoresis (PFGE)—or if no isolate was available for PFGE—by antibiotic sensitivity pattern (antibiogram) that demonstrated sensitivity to only rifampin, vancomycin, and linezolid. Cases either had clinical symptoms or were identified by surveillance culture. Hospital charts of inpatients were reviewed for age, gender, admitting diagnosis and date, surgical procedures and dates, and outcome.

Case Identification: From October 3, 2005 to December 8, 2005 surveillance cultures were obtained from all inpatients twice a week. Surveillance cultures were obtained from multiple sites (wound, skin, nares) during dressing changes or surgical debridement procedures when appropriate to minimize patient discomfort.

Environmental Surveillance Cultures: A variety of environmental surfaces (patient rooms, recovery room, hyperbaric room, and tub room and hydrotherapy room) accessed by patients and staff were cultured before and after terminal environmental cleaning by ACDC personnel. In addition, hospital personnel performed environmental cultures on the burn unit operating rooms, staff soap dispensers and nursing counter area. All cultures positive for MRSA were submitted for PFGE.

Staff Identification and Surveillance: To determine which staff had the most contact with the cases, ACDC staff reviewed the hospital charts and recorded the physicians and ancillary personnel who had hands-on contact with the patients and their wounds. ACDC also reviewed the nurse assignment rosters for 3-5 days before cases had a positive culture for MRSA to identify those whose primary assignment was to eight or more cases.

ACDC also requested surveillance cultures from the healthcare workers (physicians, nurses, assistants, and others) who had contact with all or most of the cases. In addition, we also requested surveillance cultures from the primary housekeeping personnel. The facility chose to culture additional clinical personnel. Culture sites included nares, axilla, groin, stool, and, in selected cases, hands.

Molecular Epidemiologic Investigation: PFGE was performed on all available MRSA isolates (patient, staff, and environmental) by the LAC Public Health Laboratory. Individual DNA fingerprint patterns were produced for isolates using the restriction enzymes *SMA* I and *Eag* I. Isolate relatedness was determined according to the criteria by Tenover. Isolates were compared to others gathered in LAC and to national databases. The Centers for Disease Control and Prevention were consulted regarding the identification of the predominant outbreak clone

Infection Control Evaluation and Measures: On October 4, 2005, ACDC closed the unit to all new admissions through October 7, 2005. The unit re-opened for one week. However, on October 14, 2005, after notification that 3 of 6 previously MRSA negative patients were now surveillance culture positive, the unit was closed to elective admissions. The decision was made to keep the facility closed until it could be demonstrated that MRSA transmission had ceased for an entire week as evidenced by no new positive surveillance or clinical cultures for MRSA.

During the temporary closure, emergency admissions were permitted with the permission of the ACDC administrative officer of the day, and day surgeries were permitted only if patients and surgical and recovery room staff were kept separate from the unit staff and waiting room. ACDC also approved elective day surgery admissions to a separate floor as long as contact precautions and other control measures were maintained. Prospective patients were notified of the outbreak before admission.

Standard infection control measures including staff education, contact isolation for all patients (with or without MRSA), cohorting patients and staff, and terminal cleaning were implemented in a stepwise progression during the outbreak period. Terminal environmental cleaning of all bedside equipment and environmental surfaces[1] was performed several times during the outbreak, including steam cleaning the tub, shower and hydrotherapy rooms. All disposable supplies and equipment were discarded.

Personnel from the California Department of Health Services, Health Facilities Division, made a site visit and observed infection control practices in the facility and during surgery.

All patients in this unit were discharged by November 26, 2005 and the unit remained empty until November 28, 2005. Terminal cleaning of all surfaces took place in this time period and staff were decolonized as per protocol. ACDC recommended that selected healthcare personnel (those with hands on contact with the cases) be decolonized with a five-day treatment with intranasal mupirocin ointment and chlorhexidine soap. Treatment was to commence after the last contact with patients known to have MRSA.

RESULTS

Case Characterization: Between August 22, 2005 and November 30, 2005, 27 patients were identified with positive MRSA cultures, of which 23 (85%) met the case definition. Of these 23 cases, 20 were male (3 children, 17 adults) and 3 were female (1 child, 2 adults). Ages ranged from 11 months to 75 years, with a median age of 33 years. While one case was admitted for repair of keloid scars, the remaining (n=22) were admitted with some type of acute burn injury (e.g., tar, hot oil, or flash burns). Most (n=15, 56%) were admitted with second or third-degree burns. Of the 23 cases, 8 (38%) had symptoms of clinical infection (3 bloodstream, 5 wound) and 15 were colonized and identified by nasal and/or wound surveillance cultures. Many of the wound surveillance cultures were obtained during surgical debridement

1. As determined by both hospital policy and the 2003 Guidelines for Environmental Infection Control in Health-Care Facilities: Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee available at: www.cdc.gov/ncidod/hip/enviro/guide.htm.

procedures, which were the only time the bandages were removed from the wounds. One critically ill case with MRSA in the blood died; it is unknown if the MRSA was a direct cause of death.

Of the 23 cases, 4 were identified by surveillance cultures while they were receiving outpatient treatment for their burns by burn unit personnel. The date of discharge to positive culture date had a range of 70 (9 to 79 days), and a median of 15 days. Of the 19 cases who were hospitalized at the time of culture, the time between admission to the burn unit and positive culture date ranged from 4 to 13 days with a median of 10 days.

Surgical debridement procedures were performed on 14 of 16 cases with available medical information; 12 received multiple surgical debridement procedures during their hospitalization. One case had a surgical repair as a result of a past burn injury and did not undergo surgical debridement, and one case did not have any surgical procedures.

Four other patients were diagnosed with MRSA due to a variety of other strains during this time period, including three patients with clinical infections and one who had positive surveillance cultures.

Environmental Surveillance: Of the 25 burn unit samples obtained prior to terminal cleaning, 10 were culture positive for MRSA (hydrotherapy room bed, cabinet, and radio; shower handrails; patient room nurse recall control and bathroom door knob; nurse desktop; hyperbaric room videos; patient room bedrails; recovery room chart counter/desktop drawers). After terminal cleaning, 15 repeat environmental cultures were obtained and included 10 previously MRSA positive and 5 MRSA negative sites. All previously positive sites returned negative, but one previously negative site (tub-room silver railing) was positive for MRSA. Of the 13 burn OR samples obtained, 1 was culture positive for MRSA (lamps in OR #1). Neither of the soap dispenser sites nor the nursing counter area were positive for MRSA.

Staff Identification and Surveillance: The study identified five nurses who had the greatest number of contacts with cases as compared to the number of contacts with the control group. ACDC requested staff surveillance cultures from 17 health care workers (10 physicians, 1 physician assistant, 5 nurses, 1 burn technician) who had the most frequent contact with the cases and 3 environmental services (housekeeping) staff. The hospital staff cultured an additional 33 healthcare workers, for a total of 53 staff who received surveillance cultures. Of the 53 staff members tested, 3 were MRSA positive on initial culture (a nurse and two physicians).

MRSA Phenotypic and Genotypic Characterization: Review of the antibiotic sensitivity patterns showed that five of the initial seven cases had essentially identical multi-drug resistance patterns. These isolates were sensitive to only rifampin, vancomycin and linezolid—which is consistent with MRSA of healthcare origin. Also, isolates from 13 additional MRSA positive patients identified through surveillance cultures had the same antibiotic resistance pattern. Two cases had isolates that were sensitive to several antibiotics (including rifampin, vancomycin, linezolid, tetracycline, trimethoprim-sulfamethoxazole, amikacin, ciprofloxacin, gentamycin, imipenem and moxifloxacin).

Most (24 of 27) of the MRSA isolates were available for PFGE; of these, 21 were indistinguishable from each other with zero band differences. The CDC identified this strain as the “Brazilian” clone. One isolate was determined to be “untypeable” by PFGE and two isolates were different from the outbreak strain and from each other.

PFGE tests were also performed on 12 environmental isolates; and 7 isolates (all from pre-cleaning) appeared to have a similar if not indistinguishable PFGE pattern to the USA 300 community-associated (CA) MRSA strain; three had a similar if not indistinguishable PFGE pattern to the outbreak strain (including an OR sample, a pre-cleaning sample, and a post-cleaning sample), and the remaining two (pre-cleaning samples) were indistinguishable from each other but did match any other strains associated with this outbreak.

As determined by PFGE, one of the physicians and the nurse (both nares isolates) had the outbreak strain. The other physician (hand isolate) did not have the outbreak strain.

Outcomes of Infection Control Measures: Because of the closure of the unit by ACDC, the census in the facility went from a daily average of 12 (for the months of August, September and October) to a daily average of 4 in the month of November. Some elective patients chose to be admitted elsewhere when told of the ongoing outbreak. Repeated site visits and monitoring by the infection control practitioner revealed good adherence to standard and enhanced infection control measures (contact precautions, washing hands, limiting of visitors). However, the DHS Health Facilities evaluator identified several problems in the operating room that seemed minor at first, but when taken as a whole, showed a significant breakdown in surgical infection control (i.e., keeping the operating room suite doors open during procedures, etc.). The Health Facilities Unit's deficiency report of findings resulted in the facility providing a plan of corrective action and permanent operating room policy and procedure changes.

ACDC recommended decolonizing the two staff members with the outbreak strain of MRSA. Staff identified as MRSA surveillance culture positive were restricted from direct patient contact until fully decolonized and repeatedly negative on subsequent cultures. After the decolonization protocol, the 2 staff members with the outbreak strain tested negative for MRSA. The other physician was felt to be transiently colonized with a separate strain (repeat cultures, before decolonization, were negative) and the decolonization protocol was not required. As a precaution, the hospital decided to decolonize *all* burn unit staff; a total of 51 staff followed the decolonization protocol.

DISCUSSION

This report describes a prolonged MRSA outbreak, the measures taken to identify and interrupt the source of transmission, and the discovery of a rare MRSA clone. Several studies document the role of nursing workload and staffing patterns in the spread of MRSA and closing the unit to new admissions as an effective control measure [6]. However, decreasing workload (by closing the unit to new admissions) and good adherence to infection control did not appear to play a significant role in the limiting the spread of this pathogen, since MRSA transmission continued to occur, despite generally good adherence to contact precautions, environmental cleaning, and reduced census. MRSA transmission was ultimately contained after the unit was completely closed and terminally cleaned, and after all staff received decolonization and culture positive staff were barred from treating patients until they testing negative. A single source for this outbreak was not identified but we surmise that personnel were the most likely source of the MRSA given the continued spread of MRSA despite adequate infection control and that the nurse and physician who tested positive for the outbreak strain had significant contact with all the patients and their wounds. Of note, 4 patients were identified after discharge while they were receiving outpatient therapy for their burns and their only ongoing connection to the facility was personnel who treated both in and outpatients. However, other forms of transmission could not be ruled out.

Upon CDC review of the PFGE pattern, it was determined that the outbreak isolate was the Brazilian "clone" rarely seen in the United States. The Brazilian clone is the most common type of MRSA in parts of South America and has been reported in Hungary and Portugal, Argentina, Uruguay, Chile and the Czech Republic [3]. We know of only one other report of this strain causing an outbreak in the United States. In previous publications, it has been recognized that a substantial number of hospital-acquired infections are caused by unique MRSA epidemic clones, and these organisms should be recognized as a major global health problem [1,5]. Also, in addition to the outbreak strain there were five distinct MRSA strains identified among the patients and staff, and three distinct MRSA strains identified in the environmental cultures, of which two of the environmental MRSA strains were not represented in the patient strains and two of the patient strains were not found in the environment. It is notable that the majority of environmental isolates were the community-associated, USA 300 strain, which has been linked to outbreaks of skin infections, yet no patient had evidence of this strain. It is possible that the adherence to infection control prevented the spread of this strain (and the other non-outbreak strains) from the environment to the patients.

This persistent MRSA outbreak lasted 2 months. The organism endured in the burn unit despite enhanced infection control measures and the diligence of the staff. It is controversial to screen healthcare personnel for MRSA during an outbreak. Our standard policy is to not perform surveillance cultures on healthcare personnel as part of the initial response to controlling an outbreak because it is unclear what to do with non-epidemiologically linked personnel who are colonized with significant organisms. However, in the situation of continued transmission despite aggressive infection control, early screening of epidemiologically linked staff for MRSA and surveillance cultures may be helpful to determine the source of transmission and prevent further transmission.

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