

Concise Communications

Implication of a Healthcare Worker With Chronic Skin Disease in the Transmission of an Epidemic Strain of Methicillin-Resistant *Staphylococcus aureus* in a Pediatric Intensive Care Unit

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ABSTRACT

This outbreak of colonization of neonates in a 10-bed pediatric intensive care unit illustrates the probable role of a healthcare worker (HCW) in the transmission of methicillin-resistant *Staphylococcus aureus*, despite good hygienic practices. It raises the issue of preventive exclusion of HCWs affected by chronic skin disease from high-risk units (*Infect Control Hosp Epidemiol* 2003;24:299-300).

Following the detection of two cases of neonatal colonization (throat and stools) with methicillin-resistant *Staphylococcus aureus* (MRSA) by routine surveillance cultures in a 10-bed pediatric intensive care unit in September 2000, an epidemiologic study was undertaken to stop the dissemination of this bacterium in the ward.

METHODS

The investigation included a retrospective study of medical and microbiological records; a bacteriologic screening of throat and stool specimens from the hospitalized neonates on admission (for new patients), every week, and at discharge; and a nasal sampling of all of the healthcare workers (HCWs) in the unit. The strains of MRSA collected during the study were typed by pulsed-field gel electrophoresis using *Sma*I for macrorestriction.

RESULTS

From September 2000 to March 2001, four cases of MRSA colonization but no infection were found among neonates. Two were ascertained cases (colonization that occurred during the stay in the pediatric intensive care unit) and two were probable cases (colonization on admission to another unit after a stay in the pediatric intensive care unit). One of the ascertained cases involved a neonate hospitalized for several months and colonized at the entry site of a tracheotomy. No treatment was instituted for any of the four patients to eradicate colonization.

Of the 42 HCWs working in the unit, two nurses were shown to harbor closely related strains in their nostrils (HCWs I and II) in November 2000. A careful history and physical examination disclosed no symptoms of staphylo-

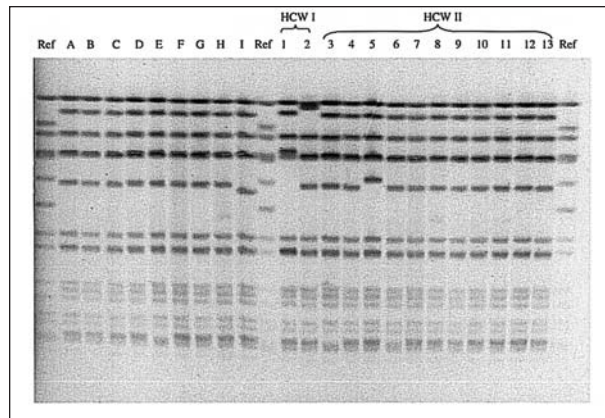


FIGURE 1. Typing by pulsed-field gel electrophoresis of methicillin-resistant *Staphylococcus aureus* strains isolated from patients and healthcare workers (HCWs) during the outbreak. Two strains were considered to have the same clonal origin if their profiles differed by no more than 1 band. Lanes A to I: strains isolated from the colonized children of the pediatric unit. Lanes 1 and 2: strains recovered from 2 successive nasal samples of HCW I. Lanes 3 to 13: strains recovered from the nose (3) and different skin sites (ear [4], perineum [5], anus [6], axilla [7], right wrist [8], left hand [9], left wrist [10], neck [11], right hand [12], and neck [13]) of HCW II. Ref: strain National Collection of Type Cultures 8325 of *S. aureus* used as the control.

coccal infection and no skin lesions. They were treated by application of an antibiotic cream (mupirocin) to the nose twice daily and by showers once daily using a soap containing polyvidone iodine for 5 days. Despite the reinforcement of hygienic measures (eg, contact precautions with gowns and gloves in a private room), a pseudo-bacteremia with MRSA occurred 2 months later in January 2001 in a child on the same unit (a MRSA strain was isolated from a single blood culture sample despite the child's lack of colonization with MRSA). In this hospital, the efficacy of MRSA eradication from the nose was usually checked 3 months after the initiation of treatment. However, due to the isolation of this MRSA strain from a blood culture sample that was shown to have been drawn by HCW II, the follow-up sampling of the two HCWs previously found to be colonized with MRSA was done at that time.

No MRSA was recovered from the nasal specimens of HCW II, but the physical examination revealed extensive eczema involving the entire body. Bacteriologic sampling of the hands, wrists, elbows, neck, axilla, ears, perineum, and anus was done and all of these skin samples were shown to harbor MRSA. After inquiry, HCW II reported a history of chronic eczema with numerous relapses. At the same time, MRSA was recovered from the second nasal specimen of HCW I. Molecular typing of all MRSA isolates showed that all isolates of the four colonized children shared the same profile and that this profile was either identical to or closely related to that of all isolates from the two HCWs (Fig. 1).

With her agreement, HCW II was excluded from the

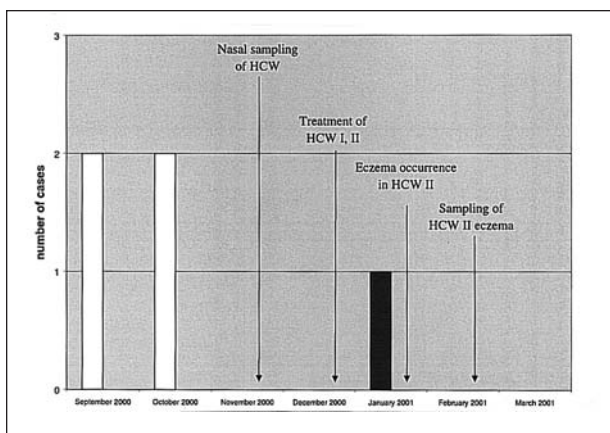


FIGURE 2. Chronology of patients' colonization (white bars), pseudo-bacteremia (gray bar), and events in healthcare workers (HCWs) during the outbreak of colonization with methicillin-resistant *Staphylococcus aureus* in the pediatric intensive care unit of the University Hospital of Saint-Étienne, France, September 2000 to March 2001.

intensive care unit during the treatment of eczema and was moved to another unit of the hospital after eradication of MRSA skin carriage. No additional treatment was offered to HCW I. During the 6-month period after this outbreak, no new cases of MRSA colonization were observed in the pediatric intensive care unit (Fig. 2).

DISCUSSION

The investigation of this hospital-acquired outbreak involving children colonized with the same MRSA strain suggested the implication of a HCW in transmission. Because no MRSA strain had been recovered during the previous months in this unit and the outbreak was concomitant with the detection of a child colonized with MRSA at a tracheotomy site, the results of the typing were useful to demonstrate that the strains were epidemiologically related. They also showed that despite the apparent efficacy of topical treatment for HCW II at the nasal level, her extensive eczema was heavily colonized with the epidemic strain. Contamination of a child's blood sample at the end of the outbreak was probably due to HCW II collecting the sample with colonized hands.

During MRSA outbreaks, most transmission is thought to result from transient hand carriage. The potential role in this outbreak of HCWs' colonization in the nose and skin is obvious. In the literature, the rates of colonization of HCWs in outbreaks due to MRSA vary from 0% to 7.5%.¹ Individuals with skin lesions caused by *S. aureus* are more likely than asymptomatic nasal carriers to disseminate the organism.² In the current outbreak, HCW II had no evident skin lesions at the first visit. Although this HCW adhered to the standard precautions and to isolation guidelines, her exclusion from the unit was decided on because (1) she worked in a high-risk unit (ie, the intensive care unit), (2) she was colonized at sites other than the nose, and (3) she remained infected at the skin level despite eradication treatment (ie, showers with antiseptic solutions).

Cox and Conquest have suggested that exclusion of HCWs is needed when even one of these criteria is present.³

This article illustrates the probable role of a HCW in the transmission of MRSA to children hospitalized in a high-risk unit, despite good hygienic practices. It also raises the issue of preventive exclusion of HCWs exhibiting chronic skin disease, who are likely to disseminate infectious agents to debilitated patients, from high-risk units.

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Mupirocin Resistance in Clinical Isolates of *Staphylococcus aureus*

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ABSTRACT

One hundred isolates of *Staphylococcus aureus* were collected in a laboratory serving several hospitals and clinics in southeastern Wisconsin and tested for mupirocin susceptibility. Only two isolates of *S. aureus* showed mupirocin resistance. The mupirocin-resistant isolates were from hospitalized patients with positive blood cultures (*Infect Control Hosp Epidemiol* 2003;24:300-301).

Mupirocin use for the treatment of staphylococcal colonization and superficial wound infections has escalated in many hospitals following an increase in colonization and infections with methicillin-resistant *Staphylococcus aureus*.^{1,2} Low-level, intermediate-level, and high-level mupirocin resistance have been reported and the mechanisms of resistance have been studied. Most clinical investigators have reported infrequent mupirocin resistance,^{3,5} although some level of resistance was shown in more than 50% of methicillin-resistant *S. aureus* isolates in another study.⁶ The clinical significance of low-level, intermediate-level, and high-level resistance is unclear and breakpoints for resistance are somewhat arbitrary. High concentrations

of mupirocin are present in topical ointments or creams and clinical studies on the efficacy of mupirocin have not always shown a correlation between efficacy and the level of resistance found.^{5,6} In this study, we tested 100 isolates of *S. aureus* for in vitro resistance to mupirocin.

METHODS

One hundred isolates of *S. aureus* were collected in a laboratory serving eight hospitals and several outpatient clinics in southeastern Wisconsin. The isolates were obtained from the laboratory in December 2001. We selected 50 methicillin-resistant isolates and 50 methicillin-susceptible isolates. Forty of the isolates were from blood cultures, half of them methicillin resistant. The other 60 isolates were from cultures of wounds, nares, urine, sputum, and a catheter tip. No isolates were intentionally excluded. None of the isolates came from a dialysis unit.

The laboratory reported specific susceptibility patterns of bacteria isolated from individual hospitals. Isolates of methicillin-resistant *S. aureus* varied from 20% to 44%, depending on the hospital. We did not study the pattern of mupirocin use at the various hospitals served by the laboratory.

Antimicrobial susceptibility testing was performed according to the guidelines of the National Committee for Clinical Laboratory Standards by using disk-diffusion methodology⁷ with disks containing 5 µg of mupirocin (GlaxoSmithKline, Collegeville, PA). The zone diameter breakpoints used for mupirocin-susceptible and mupirocin-resistant isolates were 14 mm or more and 13 mm or less, respectively.⁸ Minimum inhibitory concentrations (MICs) of mupirocin were determined by Etest methodology (GlaxoSmithKline). The MIC breakpoints of mupirocin were 4 µg/mL or less for susceptible isolates, 8 to 64 µg/mL for low-level resistance, 128 to 256 µg/mL for intermediate-level resistance, and 500 µg/mL or greater for high-level resistance.⁸

RESULTS

We found two mupirocin-resistant isolates of *S. aureus* (2%). One isolate was methicillin resistant and showed low-level resistance to mupirocin (zone diameter 7.5 mm by disk diffusion and MIC 16 µg/mL by Etest). The other isolate was methicillin susceptible and demonstrated high-level resistance to mupirocin (zone diameter 0 mm and MIC greater than 256 µg/mL). Both resistant isolates were from blood cultures. The mean zone diameter by disk diffusion was 26.65 mm for 49 mupirocin-susceptible, methicillin-susceptible isolates. The mean zone diameter was 24.62 mm for 49 mupirocin-susceptible, methicillin-resistant isolates. The mean MIC was 0.074 µg/mL for mupirocin-susceptible, methicillin-susceptible isolates. The mean MIC was 0.824 µg/mL for mupirocin-susceptible, methicillin-resistant isolates.

DISCUSSION

This study confirmed previous reports of a low prevalence of mupirocin resistance in clinical isolates of *S.*

aureus obtained from a clinical microbiology laboratory. More resistance to mupirocin might have been found if samples were intentionally collected from patients being treated with mupirocin. The clinical significance of mupirocin resistance is not well understood and staphylococcal carriage of resistant isolates can often be eradicated with topical mupirocin presumably because of high concentrations of the drug in the ointment or cream. However, some investigators have reported infections caused by mupirocin-resistant *S. aureus* in patients undergoing peritoneal dialysis who received prophylactic mupirocin at the dialysis catheter's exit site.^{9,10}

Mupirocin has often been used for eradication of staphylococcal carriage in the nose or at other wound sites (such as G-tube sites) in patients with clinical staphylococcal infections. It has also been used on small, superficial ulcers. We do not recommend prophylactic use of mupirocin without prior cultures. We did not try to correlate mupirocin use with mupirocin resistance in this study. Consultation with the pharmacy at one of the hospitals revealed that 2% to 4% of inpatients were receiving mupirocin. It is uncertain whether emergence of mupirocin resistance will significantly change the efficacy of this topical agent.

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Bacterial Contamination of Computer Keyboards in a Teaching Hospital

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ABSTRACT

We tested 100 keyboards in 29 clinical areas for bacterial contamination. Ninety five were positive for microorganisms. *Streptococcus*, *Clostridium perfringens*, *Enterococcus* (including one vancomycin-resistant *Enterococcus*), *Staphylococcus aureus*, fungi, and gram-negative organisms were isolated. Computer equipment must be kept clean so it does not become another vehicle for transmission of pathogens to patients (*Infect Control Hosp Epidemiol* 2003;24:302-303).

Nosocomial infections are a major concern to both clinicians and healthcare consumers. The emergence of multidrug-resistant organisms has made treatment of infections from these organisms costlier and more complex. During the past decade, several studies have examined the hospital environment as a source of contamination and potential risk for infection. These studies have demonstrated contamination of a variety of environmental sources, including doors, floors, tables over beds, bed rails, blood pressure cuffs, thermometers, and stethoscopes.¹⁻⁸

Recently, computers have become more prevalent in the hospital environment. Although published reports have noted the presence of nosocomial pathogens on computers in selected locations such as burn units and intensive care units,^{9,10} there are no data on the rate of contamination of computers across the medical center spectrum. In the Veterans Affairs Medical Center of Washington, DC, more than 2,000 computers are used for many aspects of medical care; computer workstations are used by all levels of staff throughout the hospital. This study was undertaken to evaluate the extent of contamination of computer keyboards in the acute care, ambulatory care, and long-term-care areas of this medical center.

METHODS

Setting

This study was conducted at an inner-city, tertiary-care Veterans Affairs Medical Center. There are 167 acute care beds, including medical and surgical intensive care units. There are 120 long-term-care beds, including sub-acute, hospice, respite, and long-term care. The ambulatory care clinics, including an emergency department and a hemodialysis unit, had more than 650,000 patient visits in 2000. The medical center has had a significant problem with drug-resistant organisms.

There are approximately 2,000 desktop computers networked throughout the medical center, including all inpatient areas, intensive care units, the operating room, and ambulatory care areas. A fully computerized system for accessing patients' medical records has been operational for more than 2 years. Almost all staff use stationary computers

throughout the day for a wide variety of functions (ie, order entry, input of patient notes, access to laboratory data, and digital imaging results). In addition, laptop computers are transported to patient bedsides by physicians and nurses to enter data such as vital signs, progress notes, orders, and results of diagnostic tests. Computers are also affixed to medication carts for recording medication administration. Although most keyboards are used frequently throughout the day, there is no specific method or group assigned to clean computer keyboards on a routine basis.

Procedures

During a 4-week period, 100 specimens were collected from computer keyboards that were in close proximity to patients in high-use areas of the acute care, ambulatory care, and long-term-care areas. Keyboard specimens were taken from the following locations: 12 from acute medicine, 17 from acute surgery, 2 from inpatient neurology, 15 from long-term care, and 54 from ambulatory care areas including the emergency department and the hemodialysis unit. A single sterile swab moistened with 0.5 mL of modified Stuart's bacterial transport media was moved over all keyboard surfaces and immediately transported to the microbiology laboratory. The specimens were inoculated onto trypticase soy agar with 5% sheep blood, MacConkey agar, phenyl ethyl alcohol agar, and thioglycollate broth (Remel, Lenexa, KS). The specimens were incubated at 35°C for 48 hours. Isolated organisms were identified using Gram stain, colony morphology, colony pigmentation, catalase, motility, urea, esculin hydrolysis, growth in 6.5% NaCl, coagulase tests, aerobic and anaerobic growth in thioglycollate broth, the VITEK Gram Negative Identification System, and the VITEK Gram Positive Identification System and Analytical Profile Index (bioMérieux Inc., Hazelwood, MO). Susceptibility testing was performed on all *Staphylococcus aureus* and enterococcal isolates by disk diffusion and the VITEK System.

RESULTS

Of 100 cultures performed, 95 had growth of one or more microorganisms. As shown in the table, most were positive for skin organisms: 84 for coagulase-negative *Staphylococcus*, 44 for *Bacillus* species, and 8 for *Corynebacterium* species. There were 9 keyboard cultures positive for streptococci, 4 for *Clostridium perfringens*, 4 for enterococci (including 1 for vancomycin-resistant *Enterococcus*), 1 for *Staphylococcus aureus*, 2 for *Pseudomonas luteola*, 6 for gram-negative rods, and 2 for fungi. Five of 100 cultures showed no growth of microorganisms. Three of 5 cultures from the operating room were negative, whereas only 2 of 95 cultures from other patient-care areas were negative.

DISCUSSION

In this study, we found that 95% of the cultures from computer keyboards were positive for microorganisms. Although most of these isolates were traditional skin flora, we were concerned that 5% were positive for pathogens

known to be associated with nosocomial transmission, such as *Staphylococcus aureus* and enterococci. In addition, other organisms such as gram-negative rods, anaerobes, yeast, and streptococci cultured from computer keyboards revealed a general level of contamination of this widely used equipment.

The hospital environment plays a critical role in the transmission of organisms associated with nosocomial infections. This has been demonstrated for several important pathogens, including *Clostridium difficile*,¹ *Staphylococcus aureus*,⁴ and vancomycin-resistant *Enterococcus*.⁶ In addition to contamination of fixed structures such as floors and walls, several smaller items in the healthcare environment have been contaminated with potential pathogens. Vancomycin-resistant enterococci have contaminated electronic thermometers, blood pressure cuffs, and urine containers.^{3,6} Resistant *Staphylococcus aureus* has contaminated a variety of objects, including blood pressure cuffs, stethoscopes, and nurses' uniforms.^{4,7,8}

Computers have become ubiquitous in the hospital environment. In our hospital, both fixed and mobile computers are present in patient rooms, offices, examination rooms, operating suites, and other clinical and non-clinical areas. Two studies have demonstrated that computers in selected units can become contaminated with pathogens. Neely et al. demonstrated that plastic computer keyboard covers became contaminated with *Acinetobacter baumannii* in a pediatric burn unit.⁹ In a non-outbreak setting in an intensive care unit, repeated sampling of 10 computers demonstrated that 8 were contaminated at some point with potential pathogens.¹⁰

Our study is the largest to date that examines bacterial contamination of computers in a wide variety of settings. It is of concern that computers in all areas of the medical center were contaminated with microorganisms. It is of interest that in the operating room, where there is heightened awareness of hand hygiene and environmental sanitation, 3 of 5 cultures had no growth of organisms.

Healthcare workers must understand that computers represent yet another item in the medical care setting that needs to be considered as a possible source of nosocomial infection. Cleaning of computer equipment must be incorporated into routine cleaning procedures. Options include plastic keyboard covers, or solid, water-resistant keyboards, both of which can be sanitized on a routine basis.

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TABLE
BACTERIAL ISOLATES FROM COMPUTER KEYBOARDS

Organism	No. of Keyboards With Organisms Isolated (N = 100 Keyboards)
Skin flora	
<i>Staphylococcus</i> , coagulase negative	84
<i>Bacillus</i> species	44
<i>Corynebacterium</i> species	8
<i>Micrococcus</i>	4
<i>Lactobacillus</i>	2
Potential pathogens	
<i>Streptococcus</i>	
<i>S. viridans</i>	8
Group D <i>Streptococcus</i>	1
<i>Pseudomonas luteola</i>	2
Gram-negative rods	6
<i>Clostridium perfringens</i>	4
<i>Enterococcus</i> (1 vancomycin resistant)	4
Fungi	
<i>Aspergillus niger</i>	1
<i>Streptomyces griseus</i>	1
<i>Staphylococcus</i>	1
No growth	5

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