Original Article

Association between Isolation Sites of Methicillin-Resistant *Staphylococcus aureus* (MRSA) in Patients with MRSA-Positive Body Sites and MRSA Contamination in Their Surrounding Environmental Surfaces

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(Received April 25, 2007. Accepted August 20, 2007)

**SUMMARY**: In 106 inpatients with methicillin-resistant *Staphylococcus aureus* (MRSA)-positive body sites, MRSA contamination on their surrounding environmental surfaces and the palm of their dominant hand were detected and quantified. The association between MRSA-positive sites (palm of dominant hand, sputum, nasal discharge, pharyngeal mucosa, open pus, closed pus, urine, feces, and others) in patients and MRSA contamination in their surrounding environmental surfaces was evaluated by quantification theory II of multivariate analysis. The surrounding environmental surfaces were contaminated with MRSA in 54 (50.9%) of the 106 patients. The contamination of MRSA was 380.2 ± 2,198.0 colony forming units (cfu)/100 cm² in 41 (40.2%) of 102 bed linen samples, 15.2 ± 69.5 cfu/100 cm² in 19 (22.4%) of 85 overbed table samples, 12.8 ± 56.5 cfu/about 100 cm² in 18 (20.9%) of 86 bed side rail samples, and 0.2 ± 1.3 cfu/entire handle surface in 2 (2.7%) of 74 samples of room door handles on the inner side of the patients’ room doors. In the palm, 6,743.3 ± 65,446.5 cfu/palm MRSA was detected in 29 (29.6%) of 98 patients. MRSA in patients’ palms had the most marked influence on MRSA contamination of their surrounding environmental surfaces. When MRSA is detected in patients’ palms, the possibility of MRSA contamination of their surrounding environmental surfaces is high.

**INTRODUCTION**

Hospital environmental surfaces contaminated with multiple resistant bacteria have been suggested to be a reservoir of infection (1). Therefore, the guidelines of the Centers for Disease Control and Prevention (CDC) and the Food and Drug Administration (FDA) show the necessity for disinfection of the environment surrounding patients (2). German expert-based infection control guidelines recommend routine disinfection of surfaces like ward floors and walls (3), while Rutala and Weber described that the use of disinfectants on non-critical patient care surfaces (e.g., bed side rails) and for housekeeping surfaces (e.g., floors) is reasonable (4,5). However, there are insufficient data on the state of contamination of the hospital environment with multi-resistant bacteria. For example, even data on methicillin-resistant *Staphylococcus aureus* (MRSA), which is the most serious problem, is inadequate (6-12). Therefore, when the environment surrounding patients with MRSA-positive body sites is disinfected, which MRSA-positive body site patients require intensive disinfection of their surrounding environmental surfaces is unclear. In this study, we performed a survey of MRSA contamination in the environment surrounding patients with MRSA-positive body sites and evaluated the association between MRSA contamination in their surrounding environmental surfaces to identify those patients that particularly require disinfection of their surrounding environmental surfaces.

**MATERIALS AND METHODS**

Quantification of MRSA on surfaces: The subjects were 106 inpatients at Yamaguchi University Hospital (756 beds) in whom MRSA was isolated from clinical materials between September 2003 and September 2004. The age of the 106 patients with MRSA-positive body sites ranged from 0 to 91 years. MRSA was positive in sputum in 35 patients, open pus in 21, feces in 21, nasal discharge in 16, pharyngeal mucosa in 13, urine in 6, closed pus in 4, blood in 2, and bronchial aspirates, intravenous hyperalimentation (IVH) catheters, and bile in 1 each. MRSA contamination was examined in the surrounding environmental surfaces of these patients (bed linens, overbed table, bed side rails, and room door handle) and the palm of their dominant hand. The control subjects consisted of 21 patients negative for the culture test of nasal cavity swabs for MRSA. The age of the 21 control patients ranged from 41 to 81 years. MRSA contamination in their surrounding environmental surfaces and the palm of their dominant hand were also evaluated.

For sampling, the surfaces of the following items were wiped using swabs moistened with sterile physiological saline: bed linens, overbed table, bed side rails, and room door handle. For the bed linens, an area (about 10 × 10 cm) near the head of the patient was examined. An area of about 1 × 100 cm was examined for the side rails of the bed, an area of about 10 × 10 cm for the overbed table, and the entire surface of the room door handle. In addition, the entire surface of the palm of the patient’s dominant hand was also examined by the swab method.

The swab used for wiping was placed in a tube containing 1 mL sterile physiological saline. This tube was ultrasonicated (Sine Sonic 100; Ikemoto Rikagaku, Co., Tokyo, Japan) at 36 kHz for 5 min and swirled for 30 s. Each sample was diluted...
10-fold, 100-fold, and 1,000-fold in sterile saline; 0.2 mL of each dilution and of an undiluted sample were plated on salt egg yolk agar plates (Nissui Pharmaceutical, Co., Tokyo, Japan). These salt egg yolk agar plates were incubated at 35°C for 48 h. Yellow colonies on the plates with a pearl-ring formation in the surrounding medium were examined by Gram-staining, morphological examination, the coagulase test (STAPHYLO LA SEIKEN®, Denka Seiken, Co., Tokyo, Japan), and examination using an Api Staph® (Analytab Products, Plain View, N.Y., USA) to determine whether they were S. aureus. STAPHYLO LA SEIKEN® is based on the agglutination method and is composed of a latex suspension which is coated with human fibrinogen and rabbit IgG.

The methicillin sensitivity of the cultured S. aureus was determined using the MRSA screen agar containing 6 μg/mL oxacillin (Nippon Becton Dickinson, Co., Tokyo, Japan). When 10 colony forming units (cfu) of S. aureus or more were detected, 10 colonies were randomly selected, and their methicillin sensitivity determined. The MRSA or methicillin-sensitive S. aureus (MSSA) count per swab was estimated from the ratio of methicillin-resistant to methicillin-sensitive colonies. The experiments were performed once (8).

In Yamaguchi University Hospital, after the patients with MRSA-positive body sites leave their room, objects in the room (such as the overbed table and bed side rails) are disinfected by wiping with 0.2% alkyl-diaminoethyl glycine. In addition, the bed linens are disinfected by hot water cleaning by the laundry services.

Data analysis: The association between MRSA-positive body sites in the patients and MRSA contamination in their surrounding environmental surfaces was evaluated by quantification theory II of multivariate analysis.

RESULTS

In the surrounding environmental surfaces, MRSA was detected in 54 (50.9%) of the 106 inpatients with MRSA-positive body sites, MSSA in 16 (15.0%), and both MRSA and MSSA in 15 (14.1%). Table 1 shows the MRSA contamination rate and contamination level in each environmental item in the 106 patients with MRSA-positive body sites. The MRSA contamination rate and contamination level in the palm of the dominant hand of the 98 patients are also shown in Table 1. Bed linens showed the highest MRSA contamination rate and level among the environmental items. However, MRSA at a level of 6,743.3 ± 65,446.5 (0-648,000) cfu/palm was detected in the palm of 29 (29.6%) of the 98 patients with MRSA-positive body sites.

Of the 21 control inpatients with MRSA-negative body sites, 4 (19.0%) showed MRSA, 3 (14.2%) showed MSSA, and 1 (4.7%) showed both MRSA and MSSA in the surrounding environmental surfaces. In the 21 controls, the MRSA contamination rate of the surrounding environmental items was 9.5% (2/21) for bed linens and 15% (3/20) for overbed tables, and the MRSA contamination level was ≤30 cfu/sample for both items. No MRSA was detected in the bed side rails, room door handles, or patients’ palms.

In this investigation, MRSA was detected in the palms of the dominant hand of 29 patients. Fig. 1 shows the degrees of the influences of MRSA-positive body sites on MRSA contamination of the surrounding environment in the 106 patients. The degree of influence was 0.404 for the palm, 0.253 for sputum, 0.224 for nasal discharge, and 0.197 for open pus. Thus, when MRSA is isolated from the palms of patients, the possibility of MRSA contamination of their surrounding environmental surfaces is high.

DISCUSSION

MRSA contamination in the surrounding environmental surfaces tends to occur in patients with MRSA colonization or infection in skin lesions such as burns (7,10,12-18), and also in patients with MRSA-positive wounds or urine (9). However, except for patients with skin disorders, patients in whom MRSA contamination in the surrounding environmental surfaces tends to occur are unidentifiable. Therefore, when the surrounding environmental surfaces were disinfected, which MRSA-positive body site patients require intensive disinfection of their surrounding environmental surfaces was unclear. The present study was performed to clarify this point. There was a close association between the isolation of MRSA from the patients’ palms and MRSA contamination in the surrounding environmental surfaces (Fig. 1). Therefore, when MRSA is isolated from in patients’ palms, those patients can be regarded as MRSA dispersers, and intensive disinfection of their surrounding environment is recommended. Among the surrounding environmental items, bed linens are particularly susceptible to MRSA contamination.

The rate and level of MRSA contamination of the surrounding environmental surfaces were lower in patients with MRSA-negative body sites than in those with MRSA-positive body sites. However, MRSA was also detected in the surrounding environmental surfaces of the negative patients. This suggests wide MRSA distribution in the hospital via the hands of medical workers (11). Therefore, disinfection of the surrounding environmental surfaces may also be necessary in patients with MRSA infection.

Table 1. Methicillin-resistant Staphylococcus aureus (MRSA) contamination of the surrounding environmental surfaces of 106 inpatients with MRSA-positive body sites

<table>
<thead>
<tr>
<th>Examined items</th>
<th>MRSA contamination rate (%) (no. of detected samples/no. of examined samples)</th>
<th>Mean ± standard deviation (range) of the contamination level (cfu/examined item)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bed linens</td>
<td>40.2 (41/102)</td>
<td>380.2 ± 2,198.0 (0 - 18,000)</td>
</tr>
<tr>
<td>Overbed table</td>
<td>22.4 (19/85)</td>
<td>15.2 ± 69.5 (0 - 480)</td>
</tr>
<tr>
<td>Bed side rail</td>
<td>20.9 (18/86)</td>
<td>12.8 ± 56.5 (0 - 380)</td>
</tr>
<tr>
<td>Room door handle on the inner side</td>
<td>2.7 (2/74)</td>
<td>0.2 ± 1.3 (0 - 10)</td>
</tr>
<tr>
<td>Room door handle on the outer side</td>
<td>4.1 (3/74)</td>
<td>0.2 ± 0.9 (0 - 5)</td>
</tr>
<tr>
<td>Palm of patient’s dominant hand</td>
<td>29.6 (29/98)</td>
<td>6,743.3 ± 65,446.5 (0 - 648,000)</td>
</tr>
</tbody>
</table>

The organism count (cfu)/100 cm² is shown for bed linens, overbed tables, and bed side rails and total area for room door handles and palms.
MRSA-negative body sites.

In England, the proposed criteria for the cleanliness of the hospital environment include a total aerobic colony count <5 cfu/cm² and an indicator organism count of <1 cfu/cm² (19). In this study, only a few samples exceeded this indicator organism count (Table 1). For example, MRSA was detected in 41 of 102 bed linen samples, but MRSA at a level above the criterion was detected in 8 (19.5%) of the 41 samples. MRSA was detected in 19 of 85 overbed table samples, but MRSA at a level above the criterion was detected in 2 (10.5%) of the 19 samples. Therefore, the criterion for indicator organisms such as MRSA should be reduced.

REFERENCES