ORIGINAL CONTRIBUTION

Incidence of Methicillin-Resistant Staphylococcus Aureus (MRSA) Isolation in a Skilled Nursing Home: A Third Report on the Risk Factors for the Occurrence of MRSA Infection in the Elderly

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A case control study was carried out in order to evaluate the various factors which may influence the occurrence of methicillin-resistant Staphylococcus aureus (MRSA) infections in a skilled nursing home. From April 1991 to March 1994, bacterial cultures were performed in 55 out of 102 residents in a nursing home based on various clinical aspects. We divided 102 residents into following three groups; (1) the MRSA group (n=10), residents whose materials for bacterial culture were positive for MRSA, (2) the non-MRSA group (n=45), residents whose specimens were negative for MRSA but positive for other bacteria, (3) the control group (n=47), residents who did not have to undergo a bacterial culture because they were free from moderate and severe infectious diseases. Compared with the control group, the activities of daily living score and the serum albumin level were significantly lower in the MRSA group and the non-MRSA group at the beginning of the study. In contrast, the number of antibiotics used prior to the bacterial culture and the proportion of hospitalization within 6 months prior to the bacterial culture were significantly larger in the MRSA group than in either the non-MRSA group, or the control group. These results thus suggest that a low activities of daily living score, the use of many kinds of antibiotics and a recent previous hospitalization may be risk factors of MRSA infection in a nursing home environment. J Epidemiol, 1996; 6: 69-73.

MRSA, ADL, antibiotics, aged, skilled nursing home

The first strains of methicillin-resistant Staphylococcus aureus (MRSA) were reported in the United Kingdom in 1961, only two years after the introduction of methicillin1). Since then, similar strains have also been isolated in other parts of the world2,3, including Japan4). Since MRSA represents a high level of resistance for all antibiotics except for a few antibiotics such as vancomycin and arbekacin5), the development of various MRSA strains has now become a serious clinical problem and is also regarded as a causative pathogen of nosocomial infections.

In particular, elderly patients have been reported to be one of the high risk groups for MRSA infection6). It is, therefore, an urgent problem to reduce the incidence of MRSA infections in geriatric hospitals and nursing homes. Colonization with MRSA is not rare among nursing home residents7,8), and the residents with MRSA colonization also run the risk of becoming infectious sources of MRSA infections following their acute hospitalizations.

Our previous studies9,10,11) showed that the disability to perform the activities of daily living (ADL), hypoalbuminemia and the use of the third generation of cephems are the important risk factors for the occurrence of MRSA infection in a geriatric hospital. However, these reports described the risk factors for MRSA isolation among the elderly in geriatric hospitals. The purpose of the present study is thus to evaluate the risk factors for the MRSA infection among the residents of a
nursing home, where there are much fewer infectious sources of MRSA infection because such residents are transferred to our hospital immediately after the detection of MRSA.

**SUBJECTS AND METHODS**

A skilled nursing home located next to a geriatric hospital had 102 (including 14 males and 88 females) residents with an average age of 81.6 ± 7.2 years old on the first of April 1991. Eighty-two residents (80.4%) were demented and 29 residents (28.4%) had a history of cerebrovascular diseases. From April 1991 to March 1994, 55 residents underwent bacterial cultures to evaluate various clinical aspects on materials which included sputum, urine and pus from decubital ulcers (Table 1). We divided the 102 residents into the following three groups; (1) the MRSA group (n=10); the residents whose materials for the bacterial cultures were positive for MRSA, (2) the non-MRSA group (n=45); the residents whose materials for bacterial cultures were negative for MRSA but positive for other bacteria such as methicillin-susceptible Staphylococcus aureus (MSSA, n=16), Streptococcac group (n=14), Escheria coli (n=5), Pseudomonas aeruginosa (n=4), Klebsiella pneumoniae (n=4) and others (n=2), (3) the control group (n=47); the residents who did not have to undergo any bacterial culture because they were free from either moderate or severe infectious diseases. In the present study, all of the non-MRSA group residents were found to be negative for MRSA but positive for other bacteria. In a geriatric hospital neighboring this nursing home, all of the residents with an MRSA infection in this nursing home had been discharged after recovering from the MRSA infection, and their specimens for bacterial culture were all found to be negative for MRSA at least twice for all patients before returning to the nursing home.

In order to evaluate the various factors which may influence the occurrence of either MRSA or non-MRSA infection, several factors which may influence the occurrence of bacterial infection were compared among three groups. The factors investigated consisted of the number of antibiotics administered prior to the bacterial culture, the age and sex of patients, the proportion of complicated diseases such as cerebrovascular disease, diabetes mellitus, or dementia, an evaluation of the activities of daily living (ADL) and the nutritional state as expressed by the serum albumin level at the beginning of the study, and any hospitalization within 6 months prior to the bacterial culture.

The number of antibiotics administered and the ADL score were determined in the same manner as that described in a previous studies, and the appropriate information was obtained from medical records of the residents.

The diagnosis of MRSA was made by the Showa monodisc method. Staphylococcus aureus, which showed resistance to both methicillin and ceftizoxime, was diagnosed as MRSA. Serum albumin was measured by using auto analyzer (Olympus, Tokyo).

The data were expressed as the means ± SD. Statistical difference was calculated using the one-way analysis of variance followed by Bonferroni method and the chi-square test.

**RESULTS**

Compared with the non-MRSA group and the control group, the MRSA group showed a lower ADL score and a larger number of antibiotics used prior to the bacterial culture (Table 2). In addition, the residents with a feeding tube were also more common for the MRSA group than in both the non-MRSA group and the control group. The proportion of the residents who had been discharged from our hospital within 6 months prior to the bacterial culture was also greater in the MRSA group than in either the non-MRSA group or the control group. In addition, the serum albumin level was lower in the MRSA group than in the control group. Compared with the control group, the ADL score and serum albumin level were lower in the non-MRSA group while the number of antibiotics used prior to the bacterial culture was greater in the non-MRSA group.

Compared with the non-MRSA group, the proportion of patients who had received third generation of cephems during the previous hospitalization was three times greater in the MRSA group and the proportion of the patients whose materials had been culture-positive for MRSA during the previous hospitalization was also four times greater in the MRSA group. In contrast, none of the control group patients had either received third generation of cephems or been positive for MRSA during the previous hospitalization. However, the proportion failed to show any significant differences among three groups.

**Table 1. Materials for bacterial culture**

| Group     | No. of cases | Sputum | Urine | Pus from decubital ulcer |
|-----------|-------------|--------|-------|-------------------------|
| MRSA      | n=10        | 2      | 6     | 2                       |
| non-MRSA  | n=45        | 5      | 39    | 1                       |
| Control   | n=47        | none   | none  | none                    |
Table 2. Differences among the MRSA, non-MRSA and control groups.

|                      | MRSA (n=10) | non-MRSA (n=45) | Control (n=47) |
|----------------------|-------------|----------------|---------------|
| Age (years old)      | 84.5±6.0    | 82.0±6.9       | 80.6±7.7      |
| Male / Female        | 0/10        | 7/38           | 7/40          |
| ADL score            | 0.2±0.4***,$| 0.9±1.0**      | 1.9±1.2       |
| Serum albumin (g/dl) | 3.8±0.4*    | 3.9±0.5**      | 4.2±0.3       |
| No. of antibiotics   | 1.7±1.2**## | 0.3±0.5**      | 0.0±0.0       |
| Use of feeding tube  | 4 (40.0%)*,#| 4 (8.8%)       | 0 (0.0%)      |
| History of CVD       | 4 (40.0%)   | 16 (35.6%)     | 9 (19.1%)     |
| Diabetes mellitus    | 0 (0.0%)    | 3 (6.7%)       | 2 (4.3%)      |
| Dementia             | 9 (90.0%)   | 38 (84.4%)     | 35 (74.5%)    |
| Hospitalization      | 7 (70.0%)**##| 8 (17.7%)      | 5 (10.6%)     |

*: p<0.05, **: p<0.01 vs Control, #: p<0.05, ##: p<0.01 vs non-MRSA
$: p<0.05 vs non-MRSA by Wilcoxon test
ADL score: the activities of daily living score.
No. of antibiotics: number of antibiotics administered prior to the bacterial culture.
History of CVD: history of cerebrovascular disease.
Hospitalization: hospitalization within 6 months prior to the bacterial culture.

Table 3. Profile of the residents who had been hospitalized within 6 months prior to the bacterial culture.

|                      | MRSA (n=7) | non-MRSA (n=8) | Control (n=5) |
|----------------------|-------------|----------------|---------------|
| Age (years old)      | 83.1±6.7    | 85.6±5.2       | 84.2±5.4      |
| ADL score            | 0.3±0.5**   | 0.3±0.5**      | 2.2±1.1       |
| Serum albumin (g/dl) | 3.7±0.4     | 3.7±0.5        | 4.2±0.5       |
| No. of antibiotics   | 1.4±1.3*    | 0.6±0.7        | 0.0±0.0       |
| Use of 3rd generation cephem during the previous hospitalization | 3 (42.9%) | 1 (12.5%) | 0 (0.0%) |
| Isolation of MRSA during the previous hospitalization | 4 (57.1%) | 1 (12.5%) | 0 (0.0%) |

*: p<0.05, **: p<0.01 vs Control.
ADL score: the activities of daily living score.
No. of antibiotics: the number of antibiotics administered prior to the bacterial culture.

**DISCUSSION**

In the present study, the ADL score was lowest in the MRSA group among the three groups, and lower in the non-MRSA group than in the control group. Patients with a limited ADL may thus have a greater chance to receive an indwelling catheter. Since the use of indwelling catheter is reported to be a risk factor for infection7,13,14, such patients are likely to receive antibiotics. In addition, an MRSA infection may occur more often in the patients with a limited ADL, who need frequent help in their daily lives and thus come in contact with numerous other people many times a day15. In the present study, the MRSA group residents had a lower ADL score and were also more common fed by tube feeding, and received more antibiotics prior to the bacterial culture than did the non-MRSA group.

In the present study, the MRSA group received a greater number of antibiotics than did the non-MRSA group, and the control group did not receive any antibiotics. This finding thus confirms that the use of many kinds of antibiotics is a risk factor for MRSA isolation as reported previously9,10,11.

A previous report revealed that hypoalbuminemia is a risk factor for MRSA infection for those who had not received third generation cephems10. In the present study, however, the serum albumin level did not differ between the MRSA group and the non-MRSA group, and it was significantly higher in both the MRSA group and the non-MRSA group than in the control group. These findings suggest that hypoalbuminemia was a risk for bacterial infection in this nursing home, in which the residents were transferred to our hospital immediately after the detection of MRSA.

In the present study, the rate of MRSA positive was 9.8% (10 out of 102). This rate was similar to the MRSA isolation rate (7.0%) of a nursing home in Tokyo, which was also located next to a geriatric hospital8. On the other hand, it was higher than the MRSA isolation rate (1.2%) of nursing homes in all
patients. In the present study, none of the residents had previous cephems increased the risk for MRSA infection in elderly people. Previous studies also showed that the use of third generation cephalosporins must increase the rapid development of MRSA. Our study described that the common use of third generation cephems, which are causative pathogens of nosocomial infections. Matsumoto also considered that serious clinical problems and are considered to be a risk factor for the development of MRSA. Since most MRSA isolates are multiply resistant to various antibiotics, the development of MRSA is a serious clinical problem. The proportion of MRSA isolates from patients directly from the community was MRSA while only 10-15% of Staphylococcus aureus isolates obtained from patients admitted from a nursing home were MRSA. These MRSA isolates from patients had proven negative for MRSA. These findings suggest that nursing home residents may thus be reservoirs of MRSA.

In the present study, 10 (18.2%) out of 55 residents demonstrating a positive bacterial culture were MRSA positive. This proportion (18.2%) was almost four times higher than that of our previous study (5.0%). This result suggests the possibility that the number of the residents with unrecognized MRSA colonization may have increased during the last three years in our nursing home even though the residents were transferred to our hospital immediately after the detection of MRSA. Since MRSA carriers develop infections more frequently than MSSA carriers, healthcare workers should thus take care to change their gloves and wash their hands between residents contacts.

In Japan, the isolation of MRSA has dramatically increased since 1982 when the third generation cephems were introduced. Since most MRSA isolates are multiply resistant to various antibiotics, the development of MRSA has become a serious clinical problem and is also considered to be a causative pathogen of nosocomial infections. Matsumoto described that the common use of third generation cephems, which have a weak antibacterial effect on Staphylococcus aureus, must induce the rapid development of MRSA. Our previous studies also showed that the use of third generation cephalosporins increased the risk for MRSA infection in elderly patients. In the present study, none of the residents had previous received third generation cephems in a nursing home, but four residents (3 in the MRSA group, 1 in the non-MRSA group and none in the control group) had received third generation cephems in the previous hospitalization. This finding supports that the use of third generation cephems is a risk factor for MRSA infection.

In the present study, twenty residents (7 in the MRSA group, 8 in the non-MRSA group and 5 in the control group) had a history of previous hospitalization within 6 months before the bacterial culture. The proportion of the residents with previous hospitalization within 6 months prior to the bacterial culture was significantly greater in the MRSA group (70.0%) than in the non-MRSA group (17.7%) or the control group (10.6%). This finding thus suggests that a previous hospitalization may be a predictor for MRSA infection among the elderly in a skilled nursing home.

Although all of them had been discharged after recovering from MRSA infections and they became culture-negative for MRSA at least twice before returning to the nursing home, five residents (4 in the MRSA group, 1 in the non-MRSA group and none in the control group) had been culture-positive for MRSA.

Murphy et al. studied the prevalence and the risk factors for MRSA colonization at a long-term care facility in the United States and found that a prior positive culture for MRSA colonization was one of the most powerful predictors of MRSA colonization. These findings thus suggest the possibility that these residents were still MRSA carriers even after their materials for bacterial culture had proven negative for MRSA.

When unrecognized MRSA carriers become common among the skilled nursing home residents, the isolation of MRSA carriers seems to be inadequate. Although the isolation of the residents may worsen dementia and/or disability to perform ADL, the infectious control by the isolation of MRSA carriers must be ineffective. In addition, Strausbaugh et al. reported that decolonization was not only ineffective but also hazardous because colonization persisted or recurred in more than half of patients, and substantial antimicrobial resistance was noted in MRSA strains isolated after therapy. For this reason, the best preventative method seems to be that health care workers carefully change their gloves or wash their hands between residents contacts.

In summary, the inability to perform ADL, the use of many kinds of antibiotics and the recent previous hospitalization may be risk factors for MRSA infection in a skilled nursing home environment. In addition, the proportion of MRSA in our skilled nursing home residents with bacterial infection in the present study was greater than that observed in a previous study even though the all residents with MRSA isolation were transferred to our hospital immediately after the detection of MRSA. Since MRSA represents a high level of resistance for almost all antibiotics, except for a few such as vancomycin and arbekacin, it may be advisable to avoid any unnecessary administration of antibiotics and unnecessary hospitalization.
when treating the elderly in skilled nursing homes. In addition, it is essential for health care workers to wash their hands and change their gloves between residents contacts because the unrecognized MRSA carriers seems to increase in skilled nursing home environments.

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