

RESEARCH ARTICLE

Methicillin-resistant *Staphylococcus aureus*: prevalence of and risk factors associated with colonization of patients on admission to the Teaching hospital, Karapitiya

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Abstract: Methicillin-resistant *Staphylococcus aureus* (MRSA) causes a substantial burden of community-acquired and nosocomial infection. Prior colonization with MRSA is a recognized risk factor for MRSA infection. This study aimed to assess the prevalence of and risk factors for MRSA colonization at admission to surgical, medical and orthopaedic wards of Teaching Hospital, Karapitiya, Sri Lanka from September 2016 to March 2017. Consecutive patients admitted to orthopaedic wards and every fifth patient admitted to medical and general surgical wards were enrolled. A nasal swab was collected from the anterior nares within 24 hours of admission and tested using standard microbiologic procedures. Clinical and demographic data were collected. A total of 502 patients were enrolled, including 152 medical, 201 general surgical, and 149 orthopaedic patients. The median age was 45 years (range 3- 85 years) and 58% of patients were male. At admission, 31 (6.2%) were colonized with MRSA. Colonization prevalence was higher in orthopaedic (18,12.1%) compared to medical (6, 4.0%) and general surgical (7, 3.5%) patients, $p=0.002$. Patients colonized with MRSA on admission were more likely to be children <18 years (29% vs 8.7%, $p=0.0003$) and male (80.6% vs 56.5%, $p=0.008$). Hospitalization, history of surgery, antibiotic intake, and healthcare-related employment within the previous six months were not associated with MRSA colonization on admission. Use of public swimming pools, history of incarceration, and use of illicit drugs were significantly associated with MRSA colonization. MRSA colonization was highest among orthopaedic patients. Improved infection control efforts and targeted decolonization may help decrease MRSA colonization.

Keywords: Colonization, MRSA, Prevalence, Risk factor

Introduction

Staphylococcus aureus is a pathogenic gram-positive bacterium which can cause a broad variety of diseases, ranging from minor infections of the skin to severe post-operative wound infections (Deurenberg et al., 2001). Approximately 30% of humans are asymptomatic nasal carriers of *S. aureus*. The primary mode of transmission is by direct contact, usually skin-to-skin with a colonized or infected individual, and contact with contaminated objects or surfaces. *S. aureus* is an extraordinarily adaptable pathogen with a proven ability to develop resistance

(Chamber and Deleo, 2009). Strains that are resistant to methicillin through the acquisition of the *mecA* mediated resistance mechanism are identified as methicillin-resistant *S. aureus* (MRSA). Infections due to MRSA may be associated with worse outcomes, including a greater risk of death, than infections due to methicillin-susceptible *S. aureus* (Melzer et al., 2003). It can be usually preceded by asymptomatic nasal colonization, which is also recognized as a significant risk factor for infection. Colonized individuals can act as reservoirs in the spread of the organism (Chamber and Deleo, 2009). The pathogen has been associated with global

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epidemics and presents new challenges for patients and healthcare systems. At present, two significant MRSA strains have been identified and categorized as hospital-acquired MRSA (HA-MRSA) and community-acquired MRSA (CA-MRSA) based on antibiotic susceptibility patterns, available genotypes, and epidemiologic risk factors (Chamber and Deleo, 2009).

The worldwide prevalence of MRSA colonization varies significantly. Asia is among the regions with the highest incidence of HA-MRSA and CA-MRSA in the world (Chen and Huang, 2014). MRSA was first reported in Sri Lanka from Teaching Hospital, Peradeniya in 1989 (Thevanesam et al., 1994). Previous studies done in Sri Lanka show varying prevalence of MRSA colonization on admission: 14.5% and 15.4% in different samples collected at General Hospital, Peradeniya in 1992 and 2003, respectively (Thevanesam et al., 1994; Thevanesam et al., 2013), 7.4% in nasal samples collected at National Hospital, Colombo in 1998 (Corea et al., 2003) and 11.9% in hand samples collected at Teaching Hospital, Jaffna in 2013 (Mahalingam et al., 2014). MRSA prevalence appears to vary significantly between distinct hospitals and different populations. Therefore, a proper approach of screening, control and prevention is needed within healthcare settings to minimize MRSA infections. This approach may include general hygiene and cleaning measures to prevent transmission, antibiotic stewardship programs and screening and decolonization in selected patients (Chen and Huang, 2014). In order to implement such programs, patients colonized with MRSA must first be identified using an appropriate surveillance method. However, published data are not available about the prevalence of MRSA colonization and community and healthcare-associated risk factors related to Teaching Hospital, Karapitiya (THK), a tertiary care hospital in southern Sri Lanka. Hence, this study was designed to assess the prevalence of and risk factors associated with MRSA colonization in the general surgical/orthopaedic and medical units of THK.

Materials and Methods

Subject identification

A prospective surveillance study was conducted at Teaching Hospital, Karapitiya, Sri Lanka. A total of eight wards in surgery, orthopaedic and medicine units were selected for the study. The study population included patients admitted to the wards from 21st September 2016 to 10th March 2017. Consecutive admissions to orthopaedic and every

fifth admission to surgery and medicine wards were selected and patients were approached for consent. Patients who were discharged or transferred within 24 hours of admission from the wards, patients who were unable or unwilling to give consent and patients who had contraindications to nasal sampling such as active nasal bleeding or recent nasal surgery were excluded. Enrolment of patients to the study was conducted at THK in accordance with the ethical standards of the Ethical Review Committee, Faculty of Medicine, University of Ruhuna and the testing were carried out at the department of Microbiology of the Faculty of Medicine.

Basic demographic and clinical data were collected by interviewing the consented patients using a standardized questionnaire and reviewing the available medical records (bed head tickets and laboratory records). Information was gathered regarding sociodemographic risk factors (age, sex, place of residence, occupation, use of public swimming pool, use of illicit drugs) and clinical risk factors in the prior 6 months (hospitalization, surgery, antibiotic treatment) associated with MRSA colonization.

Sample collection and laboratory testing

A nasal swab was collected from both anterior nares of each patient within 24 hours of admission and streaked onto staphylococci selective mannitol salt agar media (Hardy, USA). After 24-48 hours of incubation at 35°C, suspected strains that produced yellow colonies on mannitol salt agar were inoculated on blood agar. After overnight incubation, isolates were confirmed as *S. aureus* with gram staining and coagulase testing with Staph Latex agglutination assay (Staphaurex™, Thermo Fisher Scientific) (Warren et al., 2004). Testing for methicillin resistance was performed using the standard disc diffusion method with cefoxitin 30 µg disc on Mueller-Hinton agar with incubation for 24 hours at 35°C as recommended by the Clinical and Laboratory Standards Institute (CLSI, 2015). The American Type Culture Collection (ATCC) confirmed strains were used as controls to check the sensitivity and specificity of the testing at each stage of the process. The results were interpreted according to the criteria of CLSI, 2015.

Statistical analysis

Clinical data and laboratory data were analysed using STATA (13.0). Descriptive analysis was performed to determine the colonization prevalence of MRSA at admission. Sociodemographic and clinical

characteristics associated with MRSA colonization on admission were determined using Fisher’s exact test for categorical variables and Kruskal-Wallis test for continuous variables. A p-value <0.05 was considered to be statistically significant.

Results and Discussion

A total of 502 nasal swabs were collected from medical (n=152), surgical (n=201) and orthopaedic (n=149) patients. Among the total enrolled, 291 (57.97%) were male. The median age was 45 years (range 3 – 85 years) and 452 (90%) were adults (≥18

yrs.). A total of 489 patients were admitted directly from home to the hospital, and 11 patients were transferred from other hospitals (data not available for two patients).

Based on the coagulase test results, 101 (20.1%) samples were identified as *S. aureus* on admission. Of all enrolled patients, a total of 31 (6.2%) were identified as having MRSA based on the ceftaxime resistance results. Colonization prevalence was higher in orthopaedic (18, 12.1%) compared to medical (6, 4%) and general surgical (7, 3.5%) patients, p=0.002 (Table 1).

Table 1: Prevalence of MRSA colonization on admission to Teaching Hospital Karapitiya by ward type, 2016-2017

Unit	Number (%) enrolled	Number (%) with <i>S. aureus</i>	Number (%) with MRSA* among all enrolled
Surgery	201 (40.0)	21 (10.4)	7 (3.5)
Orthopaedic	149 (29.7)	50 (33.6)	18 (12.1)
Medicine	152 (30.3)	30 (19.7)	6 (4.0)
Total	502	101 (20.1)	31 (6.2)

* Methicillin Resistant *Staphylococcus aureus*

Patients colonized with MRSA on admission were more likely to be children <18 years (29% vs 8.7%, p=0.0003) and male (80.6% vs 56.5%, p=0.008). Among orthopaedic patients who were colonized with MRSA on admission (n=18), the reason for hospitalization for 16 (88%) patients, was a surgical

procedure. Of these, 10 (62.5%) had been hospitalized before the current admission compared to the surgical (1, 14%) and medical (0, 0%) patients who were colonized with MRSA on admission and had previous hospitalization.

Table 02: Risk factors assessed with the MRSA colonization on admission to Teaching Hospital Karapitiya, 2016- 2017 (bivariable logistic regression)

	All patients n = 502	Patients with MRSA ^a % n = 31	Patients without MRSA % n=471	Odds ratio (95% CI ^b)	P value
(a). On admission:					
Age (<18 years)	50 (9.9)	29.0	8.7	0.23 (0.09-0.61)	<0.001
Male sex	291 (57.9)	80.6	56.5	3.21 (1.25-9.73)	0.008
Transferred from another hospital	11 (2.2)	0.0	2.34	0.0 (0.0-5.3)	0.39
(b). Within prior six months:					
Hospitalization	149 (29.7)	41.9	28.9	1.77 (0.77-3.95)	0.12
Surgery	52 (10.3)	19.3	9.7	2.21 (0.70-5.91)	0.09
Antibiotic intake	35 (6.9)	6.5	7.0	0.91 (0.10-3.89)	0.90
Occupation; healthcare	8 (1.6)	3.2	1.5	2.20 (0.04-18.09)	0.40
Incarceration	1 (0.2)	3.2	0.0	-	<0.001
Use of public pools	18 (3.6)	12.9	2.9	4.83 (1.03-16.75)	0.004
Use of illicit drugs	1 (0.4)	4.0	0.2	17.9 (1.08-295.9)	0.005

^a Methicillin Resistant *Staphylococcus aureus*, ^a confidence interval, ^b total responded (n=457)

The presence of the following risk factors in the 6 months prior to admission were assessed for association with MRSA colonization: hospitalization, history of surgery, having a healthcare-related job, use of public swimming pools, history of incarceration, and use of illicit drugs (Table 02). Among these possible risk factors, prior hospitalization, history of surgery, and having a healthcare-related job were not significantly associated with MRSA colonization on admission. However, use of public swimming pools, history of incarceration, and use of illicit drugs showed a significant association with MRSA colonization on admission.

It has been reported that nasal carriage is more supportive of transmission than the other colonizing sites as digital manipulation could effectively disseminate the bacterium (Wertheim et al., 2006; Warnke et al., 2014). Hence, it was decided to collect nasal swabs from the patients during this study. Previous studies have shown that patients in surgical and orthopaedic wards have a higher prevalence of MRSA colonization than patients in other types of wards (Thevanesam et al., 1994; Corea et al., 2003; Thevanesam et al., 2013). In order to describe a representative MRSA colonization prevalence on admission to THK, the surgical, orthopaedic and medical wards of the hospital, which have no previously published data on prevalence, were selected for patient enrolment.

Patients colonized with MRSA can be the source of transmitting the pathogen to the hospital environment, other patients, and healthcare workers (Chambers et al., 2009; Liu, 2010). Thus, it is important to identify patients carrying MRSA early on admission to prevent transmission. Even though the overall colonization prevalence was comparatively low to what has been reported in other hospitals in Sri Lanka, the study demonstrated the highest prevalence of MRSA colonization in orthopaedic patients (12.1%) compared to medical and other surgical patients. Results indicated that 62.5% of these patients had been admitted to the hospital at least once within the 6 months before the current admission, mostly due to the postponement of the surgery date. It can be assumed that the prior hospital exposure could be a reason for having an increased prevalence of MRSA colonization in orthopaedic patients compared to other patients. However, further investigations are required to confirm this hypothesis.

It has been reported that advanced age is not a risk factor for nosocomial colonization (Corea et al.,

2003), and that colonization is more frequent among younger children compared to adults (Wertheim, 2005). In agreement with these national and international data, the study findings indicated that patients colonized with MRSA were more likely to be children (<18 years). In a study done in 1998, it was reported that patients transferred from other hospitals in Sri Lanka did not seem to be a significant source of MRSA, whereas patients with hospitalization within the prior year and antibiotic treatment within the prior two months had a significantly higher risk of MRSA colonization on admission (Corea et al., 2003). The current study did not show that patients transferred from other hospitals, prior hospitalization, or prior antibiotic intake were a significant source of MRSA. However, more than 50% of the study patients were not sure about their antibiotic intake during the past 6 months and this could be one reason for differences from previous studies.

The risk factors which were significantly associated with MRSA colonization on admission were community-related factors (use of public swimming pools, history of incarceration, and use of illicit drugs) while hospital-related factors (prior hospitalization, history of surgery, antibiotic treatment and having a health care-related job) were not associated with MRSA colonization. These data may suggest that community-associated MRSA strains may be most important in this setting as previously reported (Jernigan et al., 2006; Clinton et al., 2007). Further testing such as antibiotic susceptibility testing and molecular typing to classify types of organisms are required to confirm the results. In addition, further investigations are essential to identify the in-hospital acquisition patterns of MRSA in this setting.

Some limitations of this study must be acknowledged. Although this study was performed only in one hospital, different types of wards were covered within the largest tertiary care hospital in the Southern Province which provides both tertiary and primary-level care; thus, this population may be a reasonable representation of patients in this region. Even though overall MRSA colonization prevalence was comparatively low, colonizing MRSA strains have the potential for nosocomial transmission and subsequent infection in the hospital setting, especially on higher-prevalence wards like the orthopaedic wards. Timely and up-to-date surveillance information related to potential pathogens is essential for infection prevention and planning control measures (i.e., isolation of the colonized patient, decolonization process such as Clorox bath and

healthcare workers attending to those patients with extra care of preventing transmission) due to changing epidemiology. This study sheds light on current MRSA prevalence and the potential risk factors associated with colonization on admission to this hospital setting.

Conclusion

On admission, MRSA colonization was highest among orthopaedic patients at Teaching Hospital, Karapitiya. Patients colonized with MRSA at admission were more likely to be children and male. Use of public swimming pools, history of incarceration, and use of illicit drugs were the risk factors significantly associated with MRSA colonization in this setting. Improved infection control efforts and targeted decolonization may help decrease MRSA colonization.

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