Scientific Foundation SPIROSKI, Skopje, Republic of Macedonia
Open Access Macedonian Journal of Medical Sciences. 2023 Feb 02; 11(B):205-211.
https://doi.org/10.3889/oamjms.2023.11441
eISSN: 1857-9655
Category: *B - Clinical Sciences*
Section: *Infective Disease*

Identification of Risk Factors for Nasal Colonization of *Methicillin-resistant Staphylococcus aureus* and Vancomycin-resistant *Staphylococcus aureus* in Health Workers at a Tertiary Hospital, Indonesia

Siti Nur Rohmah[1]*, Rizka Humardewayanti Asdie[2], Ida Yosopa[3], Daya Daryadijaya[3]

[1]Department of Internal Medicine, Faculty of Medicine, Public Health and Nursing Universitas Gadjah Mada/Dr. Sardjito Hospital, Yogyakarta, Indonesia; [2]Tropical Medicine Division, Department of Internal Medicine, Faculty of Medicine, Public Health and Nursing Universitas Gadjah Mada/Dr. Sardjito Hospital, Yogyakarta, Indonesia; [3]Department of Internal Medicine, Dr. H. Soemarno Sosroatmodjo Hospital, Kuala Kapuas, Central Kalimantan, Indonesia

Edited by: Ksenija Bogoeva-Kostovska
Citation: Rohmah SN, Asdie RH, Yosopa I, Daryadijaya D. Identification of Risk Factors for Nasal Colonization of Methicillin-resistant Staphylococcus aureus and Vancomycin-resistant Staphylococcus aureus in Health Workers at a Tertiary Hospital, Indonesia. Open Access Maced J Med Sci. 2023 Feb 02; 11(B):205-211. https://doi.org/10.3889/oamjms.2023.11441
Keywords: MRSA; VRSA; Health workers; Risk factors
***Correspondence:** Siti Nur Rohmah, Department of Internal Medicine, Faculty of Medicine, Public Health and Nursing Universitas Gadjah Mada/Dr. Sardjito Hospital, Yogyakarta, Indonesia. E-mail: siti.nur.r@ugm.ac.id
Received: 29-Dec-2022
Revised: 20-Jan-2023
Accepted: 23-Jan-2023

Funding: This research did not receive any financial support
Competing Interests: The authors have declared that no competing interests exist

Abstract

BACKGROUND: Methicillin-resistant *Staphylococcus aureus* (MRSA) and Vancomycin-resistant *S. aureus* (VRSA) frequently cause nosocomial infections yearly. During the COVID-19 pandemic, the potential for excessive use of antibiotics is a global threat to the increasing incidence of multiresistant bacteria.

AIM: This study aimed to determine MRSA and VRSA colonization and identify factors associated with the risk of MRSA and VRSA nasal colonization in health workers at Dr. Soemarno Sosroatmodjo General Hospital, Kuala Kapuas, as one of the type C hospitals in Indonesia.

METHODS: This cross-sectional analytic study at Dr. Soemarno Sosroatmodjo General Hospital, a tertiary hospital in Indonesia. A 128 health workers' subjects had undergone nasal swab screening for MRSA and VRSA colonization examinations. Then, they were asked to complete a questionnaire concerning the risk factors of MRSA and VRSA infections.

RESULTS: Nasal swab results obtained as many as 30 (23.5%) MRSA positive subjects and 6 (4.7%) subjects with positive VRSA. The most common risk factors that led to MRSA colonization included a history of positive MRSA in the previous hospital (60%), a history of ear, nose, and throat infection (41.7%), and did not do hand rub/handwash (36.7%). In comparison, the most risk factors for VRSA colonization were having pigs farm at home (33.3%), a history of positive MRSA in the previous hospital (20%), and a history of hospitalization in the past 6–12 months (16.7%). The results of multivariate analysis showed the most powerful and statistically significant risk factors in influencing nasal MRSA colonization were a history of positive MRSA in the previous hospital (OR 13.69, 95% confidence intervals [CI]: 1.34–140.25, p = 0.028) and did not do hand rub/handwash (OR 2.95, 95% CI: 1.167–7.49, p = 0.023). Meanwhile, marital status (OR 0.160, 95% CI: 0.02–1.06), p = 0.058) and home care service (OR 6.10, 95% CI: 0.79–46.96, p = 0.082) were the strongest risk factors for nasal colonization of VRSA but not statistically significant.

CONCLUSION: As many as, 23.5% and 4.7% of healthcare workers' subjects were found with nasal colonization of MRSA and VRSA, respectively. Accordingly, strict policies are needed to minimize the transmission of these organisms from the hospital setting to the community.

Introduction

Antibiotic resistance to *Staphylococcus aureus* in the form of *Methicillin-resistant Staphylococcus aureus* (MRSA) and Vancomycin-Resistant *Staphylococcus aureus* (VRSA) has become a serious health problem in various parts of the world, and their prevalence continues to increase every year. The prevalence of infections caused by MRSA and VRSA has increased drastically in the past decade, affecting the length of stay, treatment costs, and infection control [1]. In 2010, the proportion of MRSA of all clinical isolates of *S. aureus* was estimated at 28% in Hong Kong and Indonesia, and 70% in Korea. Meanwhile, *S. aureus* infections found in the community among Asian countries vary widely, from 5 to 35% [2]. A total of 9.41% of MRSA isolates were found in the nasal passages of health workers who were carriers in India, but no VRSA isolates were found [3].

MRSA is the leading cause of nosocomial infections, which are infections acquired in hospitals including post-operative infections, respiratory infections, urinary tract infections, and circulatory infections. The percentage of nosocomial infection by *S. aureus* was 21.7%. Approximately 40% of *S. aureus* bacteria that can be isolated in hospitals are known to be resistant to several types of-lactam antibiotics and cephalosporins but are still sensitive to vancomycin and clindamycin antibiotics [4].

The potential for excessive use of antibiotics during the COVID-19 pandemic is a global threat to

the increasing incidence of multiresistant bacteria. A study by Lai *et al.* (2021) found an increase in multidrug-resistant organisms which include extended-spectrum-lactamase-producing *Klebsiella pneumonia*, carbapenem-resistant New Delhi Metallo-β-lactamase-producing *Enterobacterales*, *Acinetobacter baumannii*, *Candida glabrata*, multi-triazole-resistant *Aspergillus fumigatus,* and MRSA [5]. Until now, it is still not fully known how the COVID-19 pandemic directly affects antibiotic resistance and the increase in the total number of multiresistant bacteria. However, from several data studies on COVID-19 cases globally, especially in Asia, around 70% of patients received prophylactic antibiotic therapy. Although <10% of the patients who received antimicrobial treatment were proven to be coinfected with bacteria and fungi. Therefore, a stricter program for antibiotic control, infection prevention, and control is needed, especially in low-middle-income countries [6], [7].

Health workers infected or colonized by MRSA or VRSA can act as reservoirs. Health workers whom MRSA or VRSA colonizes in the long-term can be a source of infection or carriers that carry organisms in their nose and nasal sinus cavities. Most people who become MRSA carriers are asymptomatic and never show clinical symptoms [8]. Therefore, health workers need to maintain special attention to control the prevalence of MRSA and VRSA infections in hospitals. Various studies have been conducted in the world and Indonesia to determine the incidence of MRSA and VRSA, especially in health workers who work in hospitals. Only 2.6% of MRSA isolates were found in health workers at Wangaya General Hospital, Denpasar [4]. In comparison, at Dr. Moh Hosein Hospital in Palembang, it reached 46%, and Abdoel Moloek General Hospital prevalence reached 38.24%.[9] Research by Dwiyanti *et al.* (2015) identified that *S. aureus* was found in 14 paramedic nasal swab samples in the surgical treatment room and intensive care units of Ratu Zalecha Martapura General Hospital, where seven samples of MRSA were found, with seven samples of VRSA also found and from these, each sample consisted of 6 (2%) combined samples of MRSA and VRSA [8].

Risk factors for MRSA include environment, population, contact sports, personal hygiene, treatment history, surgery history, history of infection and disease, medication history, and medical conditions. Several factors that contributed significantly to increasing the incidence of MRSA were the influence of dose determination (90.4%), medication (90.2%), provision of antiseptics (84.9%), infusion cannula installation procedures (74.6%), and handwashing facilities (66.3%) [9]. A study conducted in India found that visits to health facilities in the past 1 year were a risk factor for MRSA colonization in the community [10]. A study was conducted at Dr. Saiful Anwar Hospital in Malang showed that the risk factors for patients infected with MRSA include referrals from other hospitals, history of treatment from the intensive care unit, surgery in the past 3 months, and immunocompromised patients [11].

It is important to know the risk factors for MRSA and VRSA infections in health workers so that prevention and control efforts can be made on these risk factors. In this way, it is hoped that the incidence of MRSA and VRSA can be prevented or controlled. Until now, there have been only limited studies that examined the risk factors that influence the occurrence of MRSA in health workers in Indonesian hospitals. Although research about the risk factors of MRSA in the community and health workers had been reported outside the country, the results are still controversial [10], [12], [13], [14], [15], [16], [17].

This study aimed to determine MRSA and VRSA colonization and identify factors associated with the risk of MRSA and VRSA nasal colonization in health workers at Dr. Soemarno Sosroatmodjo General Hospital, Kuala Kapuas, as one of the type C hospitals in Indonesia.

Methods

The cross-sectional analytic study used non-random purposive sampling among health workers at Dr. Soemarno Sosroatmodjo Hospital, Kuala Kapuas, Indonesia. Subjects who met the inclusion and exclusion criteria were taken non-randomly until the total number of samples was 128 people. Inclusion criteria were subjects aged at least 18 years. The exclusion criteria were having an active infection, being hospitalized, having a personality/mental disorder, and not willing to participate in the study. Subject data were collected from medical records of health workers who had undergone contact screening with MRSA and VRSA patients and had performed nasal swabs to check for MRSA and VRSA colonization. Identification and sensitivity testing of bacteria in this research sample were done with VITEK 2 using the principles of advanced colorimetry and turbidimetry.

The research subjects were then asked to complete a questionnaire concerning the risk factors variables related to MRSA and VRSA infection. The validity of the research questionnaire was tested using the Pearson Product Moment correlation test, where all questionnaire items have a value of r arithmetic >r table. Meanwhile, for the reliability test of the questionnaire, the Cronbach Alpha Coefficient test was used, where the Cronbach alpha value was 0.874 (>0.7), which means that all questionnaire items have good reliability. Samples that met inclusion and exclusion criteria were included in the study and were given a letter of approval to participate in the study. The research participants signed the consent letter to participate in the study.

Demographic, clinical, and laboratory data are presented in proportions and percentages using the Chi-square test or Fisher test for categorical data, while for numerical data in the form of average with standard deviation by unpaired t-test or median with minimum and maximum values with the Mann–Whitney test. Bivariate statistical tests were analyzed using the Chi-square or Fisher's tests to measure the relative risk ratio with 95% confidence intervals (CI). All variables with $p < 0.25$ in bivariate analysis were continued with logistic regression analysis. $p < 0.05$ was calculated to be statistically significant. Statistical analysis was performed using SPSS version 23 (IBM Corp., Armonk, NY).

Results

In this study, from the 128 subjects who underwent nasal swab examinations, 30 (23.5%) subjects were with positive MRSA results, and 6 (4.7%) subjects were with positive VRSA results. Table 1 shows that subjects with positive MRSA results were more common in women (60%) with a mean age of 36 (19–51). Meanwhile, the subjects with positive VRSA results were equally distributed between men and women, namely, three subjects (50%). Remarkably, this study found that the medical profession workers (46.7%) experienced more positive MRSA than other professions, while the nursing profession (50%) experienced positive VRSA more than other professions. MRSA positive and VRSA positive cases were more common in the emergency room (50%) than in other locations. Most subjects with positive MRSA and VRSA results had a history of contact with other patients confirmed with MRSA and VRSA.

Table 1: Baseline characteristics of subjects with nasal colonization of MRSA and VRSA

Variables	Positive MRSA (n = 30) n (%) or Median (Min-Max)	Positive VRSA (n = 6) n (%) or Median (Min-Max)
Gender		
Male (n, %)	12 (40.0)	3 (50.0)
Female (n, %)	18 (60.0)	3 (50.0)
Age (years)	36 (19–51)	32 (19–48)
Education		
Senior high school (n, %)	3 (10.0)	1 (16.7)
Diploma (n, %)	11 (36.7)	3 (50.0)
Undergraduate (n, %)	13 (43.3)	2 (33.3)
Postgraduate (n, %)	3 (10.0)	0 (0.0)
Marital status		
Married (n, %)	22 (73.3)	3 (50.0)
No (n, %)	8 (26.7)	3 (50.0)
Profession		
Doctor (n, %)	14 (46.7)	2 (33.3)
Nurse (n, %)	13 (43.3)	3 (50.0)
Laboratory analysis (n, %)	0 (0.0)	0 (0.0)
Cleaning service (n, %)	3 (10.0)	1 (16.7)
Nutritionist (n, %)	0 (0.0)	0 (0.0)
Pharmacists (n, %)	0 (0.0)	0 (0.0)
Workplace		
ER (n, %)	15 (50.0)	3 (50.0)
Ward (n, %)	9 (30.0)	2 (33.3)
Labs (n, %)	0 (0.0)	0 (0.0)
Clinic (n, %)	1 (3.3)	0 (0.0)
ICU (n, %)	4 (13.3)	1 (16.7)
Operating room (n, %)	1 (3.3)	0 (0.0)
MRSA patient contact history (+)		
Yes (n, %)	19 (63.3)	4 (66.7)
No (n, %)	4 (13.3)	0 (0.0)
Don't know (n, %)	7 (23.3)	2 (33.3)
Contact frequency		
>3× (n, %)	12 (40.0)	2 (33.3)
2–3× (n, %)	1 (3.3)	0 (0.0)
1× (n, %)	6 (20.0)	2 (33.3)
No (n, %)	11 (36.7)	2 (33.3)
Swab history before		
Yes (n, %)	8 (26.7)	0 (0.0)
No (n, %)	22 (73.3)	6 (100.0)

ER: Emergency room, ICU: Intensive care unit, MRSA: Methicillin-resistant *Staphylococcus aureus*, VRSA: Vancomycin-resistant *Staphylococcus aureus*

Various risk factors that could influence MRSA and VRSA colonization were analyzed in this study (Figures 1 and 2). Most (60%) subjects with positive MRSA had a previous history of positive MRSA at another hospital. The most common risk factors in subjects with positive MRSA include having a history of infection in the ear/nose/throat (41.7%), not doing hand rub/handwashing (36.7%), raising pigs at home (33.3%), history of hospitalization within the past 6 months (33.3%), a history of previous nasal swabs (30.8%), and living at home with a health worker (30.2%). Meanwhile, the most common risk factors for VRSA colonization include raising pigs at home (33.3%), a history of positive MRSA in the previous hospital (20%), a history of hospitalization in the past 6–12 months (16.7%), a history of hospitalization in the past 6 months (11.1%), did homecare (11.1%), and did not do hand rub/handwash (96.7%).

Bivariate (Table 2) and multivariate anayses (Table 3 and 4) were performed on the risk factor variables for nasal colonization of MRSA and VRSA to assess which were the strongest and statistically significant in influencing nasal colonization of MRSA and VRSA. Table 3 shows that a positive MRSA history from another hospital and not doing hand rub/handwash were the significantly strongest risk factors for MRSA colonization. Subjects with a positive history of MRSA from other hospitals had 13.69 times significantly higher risk for causing positive MRSA colonization (OR 13.69, 95% CI: 1.34–140.25, $p = 0.028$). Subjects who did not do hand rub/handwash had 2.95 times significantly higher risk for causing positive MRSA colonization (OR 2.95, 95% CI: 1.167–7.49, $p = 0.023$).

Meanwhile, Table 3 shows that marital status and homecare are the strongest factors causing VRSA nasal colonization, although the results were not statistically significant ($p > 0.05$). Subjects with marital status became a protective factor for the occurrence of VRSA nasal colonization (OR 0.160, 95% CI: 0.02–1.06), $p = 0.058$). Subjects who did homecare had 6.1 times higher risk of causing positive VRSA colonization (OR 6.10, 95% CI: 0.79–46.96, $p = 0.082$).

Discussion

S. aureus resistance occurs due to genetic changes caused by irrational exposure to antibiotic therapy. Treatment due to *S. aureus* infection generally

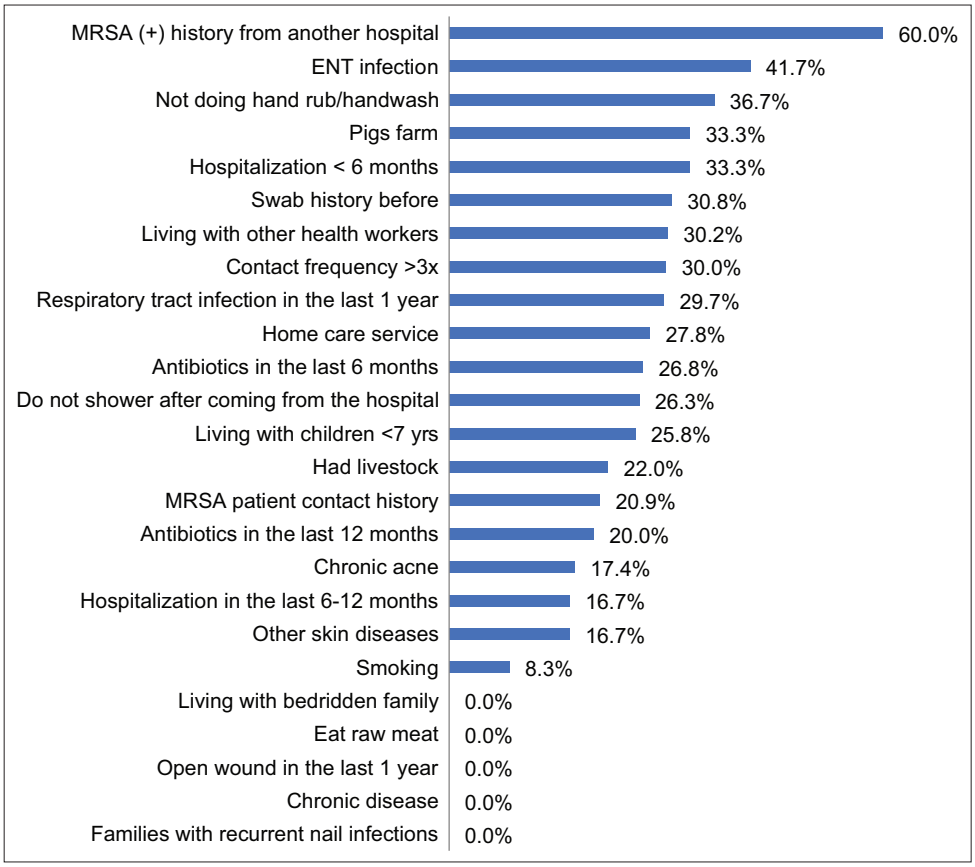

Figure 1: Distribution of the percentage of risk factors affecting nasal colonization of MRSA

uses antibiotics to inhibit growth or kill bacteria. This activity causes the emergence of antibiotic-resistant bacterial strains that complicate the treatment process so that the infection continues to spread. *S. aureus* can also experience cross-resistance to all beta-lactam antibiotics [4].

MRSA is resistant to genetic changes caused by irrational exposure to antibiotic therapy. Transmission of bacteria is transferred from one patient to another through medical devices that are not considered irritable. Transmission can also be through the air or room facilities, such as blankets or bed linen [9]. Based on research, certain strains of *S. aureus* have a remarkable ability to form colonies on hospital staff and equipment. *S. aureus* colonizes the anterior nares and other moist areas of the body. The anterior nares

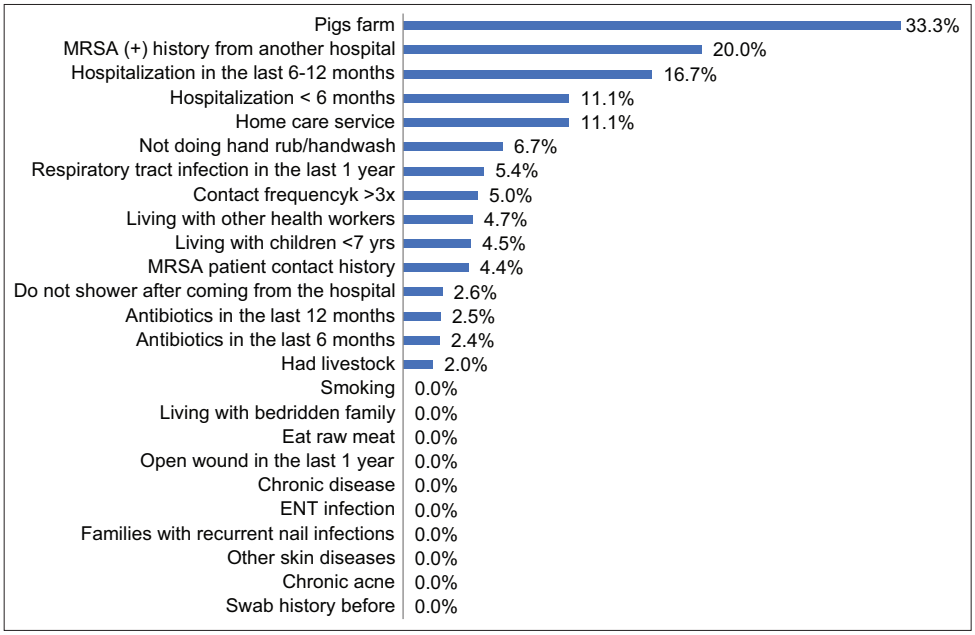

Figure 2: Distribution of the percentage of risk factors that affect nasal colonization of VRSA

Table 2: Bivariate analysis of risk factors for nasal colonization MRSA and VRSA

Variables	MRSA				VRSA			
	Positive n (%)	Negative n (%)	RR (95% CI)	p	Positive n (%)	Negative n (%)	RR (95% CI)	p
Gender								
Man	12 (31.6)	26 (68.4)	1.58 (0.85–2.95)	0.15	3 (7.9)	35 (92.1)	2.37 (0.5–11.21)	0.36
Woman	18 (20)	72 (80)			3 (3.3)	87 (96.7)		
Marital status								
Married	22 (22)	78 (78)	0.77 (0.38–1.57)	0.46	3 (3.0)	97 (97)	0.28 (0.06–1.31)	0.11
Not	8 (28.6)	20 (71.4)			3 (10.7)	25 (89.3)		
MRSA patient contact history								
Yes	19 (20.9)	72 (79.1)	0.84 (0.33–2.13)	0.74	4 (4.4)	87 (95.6)	-	0.38
Not	4 (25)	12 (75)			0 (0)	16 (100)		
Do not know	7 (33.3)	14 (66.7)			2 (9.5)	19 (90.5)		
Contact frequency								
>3x	12 (30)	28 (70)	1.01 (0.51–2)	0.97	2 (5)	38 (95)	0.93 (0.14–6.24)	1.00
<3x	1 (7.7)	12 (92.3)			0 (0)	13 (100)	-	
1x	6 (15.8)	32 (84.2)			2 (36)	36 (94.7)	0.97 (0.15–6.56)	
Not	11 (29.7)	26 (70.3)			2 (5.4)	35 (94.6)		
Swab history before								
Yes	8 (30.8)	18 (69.2)	1.43 (0.72–2.83)	0.32	0 (0)	26 (100)	-	0.34
Not	22 (21.6)	80 (78.4)			6 (5.9)	96 (94.1)		
Home care service								
Yes	5 (27.8)	13 (72.2)	1.22 (0.54–2.77)	0.76	2 (11.1)	16 (88.9)	3.06 (0.6–15.48)	0.19
Not	25 (22.7)	85 (77.3)			4 (3.6)	106 (96.4)		
MRSA (+) history from another hospital								
Yes	3 (60)	2 (40)	2.73 (1.24–6.02)	0.08	1 (20)	4 (80)	4.92 (0.70–34.65)	0.21
Not	27 (22)	96 (78)			5 (4.1)	118 (95.9)		
Chronic acne								
Yes	4 (17.4)	19 (82.6)	0.7 (0.27–1.82)	0.70	0 (0)	23 (100)	-	0.59
Not	26 (24.8)	79 (75.2)			6 (5.7)	99 (94.3)		
Other skin diseases								
Yes	2 (16.7)	10 (83.3)	0.69 (0.19–2.55)	0.73	0 (0)	12 (100)	-	1.00
Not	28 (24.1)	88 (75.9)			6 (5.2)	110 (94.8)		
Families with recurrent nail infections								
Yes	0 (0)	7 (100)	-	0.19	0 (0)	7 (100)	-	1.00
Not	30 (24.8)	91 (75.2)			6 (5)	115 (95)		
ENT infection								
Yes	5 (41.7)	7 (58.3)	1.93 (0.91–4.11)	0.15	0 (0)	12 (100)	-	1.00
Not	25 (21.6)	91 (78.4)			6 (5.2)	110 (94.8)		
Respiratory tract infection in the last 1 year								
Yes	11 (29.7)	26 (70.3)	1.42 (0.75–2.69)	0.28	2 (5.4)	35 (94.6)	1.23 (0.24–6.43)	1.00
Not	19 (20.9)	72 (79.1)			4 (4.4)	87 (95.6)		
Chronic disease								
Yes	0 (0)	1 (100)	-	0.38	0 (0)	1 (100)	-	0.85
Not	30 (24.6)	92 (75.4)			6 (4.9)	116 (95.1)		
Do not know	0 (0)	5 (100)			0 (0)	5 (100)		
Open wound in the last 1 year								
Yes	0 (0)	8 (100)	-	0.19	0 (0)	8 (100)	-	0.76
Not	30 (25.4)	88 (74.6)			6 (5.1)	112 (94.9)		
Do not know	0 (0)	2 (100)			0 (0)	2 (100)		
Antibiotics in the past 6 months								
Yes	11 (26.8)	30 (73.2)	1.23 (0.65–2.34)	0.53	1 (2.4)	40 (97.6)	0.42 (0.05–3.52)	0.66
Not	19 (21.8)	68 (78.2)			5 (5.7)	82 (94.3)		
Antibiotics in the past 12 months								
Yes	8 (20)	32 (80)	0.8 (0.39–1.64)	0.53	1 (2.5)	39 (97.5)	0.44 (0.05–3.65)	0.66
Not	22 (25)	66 (75)			5 (5.7)	83 (94.3)		
Hospitalization <6 months								
Yes	3 (33.3)	6 (66.7)	1.47 (0.55–3.92)	0.43	1 (11.1)	8 (88.9)	2.64 (0.35–20.28)	0.36
Not	27 (22.7)	92 (77.3)			5 (4.2)	114 (95.8)		
Hospitalization in the past 6–12 months								
Yes	1 (16.7)	5 (83.3)	0.7 (0.11–4.32)	1.00	1 (16.7)	5 (83.3)	4.07 (0.56–29.58)	0.25
Not	29 (23.8)	93 (76.2)			5 (4.1)	117 (95.9)		
Had livestock								
Yes	11 (22)	39 (78)	0.9 (0.47–1.73)	0.75	1 (2.0)	49 (98)	0.31 (0.04–2.59)	0.40
Not	19 (24.4)	59 (75.6)			5 (6.4)	73 (93.6)		
Pigs farm								
Yes	1 (33.3)	2 (66.7)	1.44 (0.28–7.35)	0.55	1 (33.3)	2 (66.7)	8.33 (1.361–51.24)	0.13
Not	29 (23.2)	96 (76.8)			5 (4.0)	120 (96)		
Eat raw meat								
Yes	0 (0)	0 (0)	-	-	0 (0)	0 (0)	-	-
Not	30 (23.4)	98 (76.6)			6 (4.7)	122 (95.3)		
Not doing hand rub/handwash								
Yes	11 (36.7)	19 (63.3)	1.89 (1.02–3.52)	0.04	2 (6.7)	28 (93.3)	1.63 (0.32–8.48)	0.62
Not	19 (19.4)	79 (80.6)			4 (4.1)	94 (95.9)		
Living with children <7 years								
Yes	17 (25.8)	49 (74.2)	1.23 (0.65–2.32)	0.52	3 (4.5)	63 (95.5)	0.94 (0.19–4.48)	0.94
Not	13 (21)	49 (79)			3 (4.8)	59 (95.2)		
Living with a bedridden family								
Yes	0 (0)	1 (100)	-	1.00	0 (0)	1 (100)	-	1.00
Not	30 (23.6)	97 (76.4)			6 (4.7)	121 (95.3)		
Smoking								
Yes	1 (8.3)	11 (91.7)	0.33 (0.05–2.24)	0.29	0 (0)	12 (100)	-	1.00
Not	29 (25)	87 (75)			6 (5.2)	110 (94.8)		
Did not shower after coming from the hospital								
Yes	10 (26.3)	28 (73.7)	0.84 (0.44–1.63)	0.61	1 (2.6)	37 (97.4)	2.11 (0.25–17.47)	0.67
Not	20 (22.2)	70 (77.8)			5 (5.6)	85 (94.4)		
Living with other health workers								
Yes	13 (30.2)	30 (69.8)	1.51 (0.81–2.82)	0.19	2 (4.7)	41 (95.3)	0.98 (0.18–5.18)	1.00
Not	17 (20)	68 (80)			4 (4.7)	81 (95.3)		

CI: Confidence interval, MRSA: *Methicillin-resistant Staphylococcus aureus*, RR: Risk ratio, VRSA: Vancomycin-resistant *staphylococcus aureus*.

are a major reservoir of *S. aureus* in adults and children who also play an essential role in acquired nosocomial infections in various populations [18].

Table 3: Multivariate analysis of risk factors for MRSA nasal colonization in health care workers

Variables	*P*	OR	95% CI	
			Min	Max
MRSA (+) history from another hospital				
Yes	0.028	13.28	1.33	140.25
Not				
Not doing hand rub/handwash				
Yes	0.023	2.95	1.16	7.49
Not				

CI: Confidence interval, min–max: Minimum–Maximum, MRSA; *Methicillin-resistant Staphylococcus aureus*, OR: Odds ratio.

MRSA is a major cause of nosocomial infections. The percentage of nosocomial infection by *S. aureus* was 21.7%. About 40% of *S. aureus* bacteria that can be isolated in hospitals are known to be resistant to several types of -lactam antibiotics and cephalosporins but are still sensitive to vancomycin and clindamycin antibiotics [4].

The danger of antibiotic resistance is a global health problem. In 2010, the proportion of MRSA of all clinical isolates of *S. aureus* was estimated at 28% in Hong Kong and Indonesia and 70% in Korea. Meanwhile, *S. aureus* infections found in the community in Asian countries vary widely, from 5 to 35% [4]. The number of cases of MRSA infection in Dr. M. Djamil General Hospital was 200 cases recorded from January 2014 to June 2014 [19].

Out of the 128 health workers who underwent nasal swabs, 30 (23.5%) subjects had positive MRSA in this study. This follows a study by Maheasy *et al.* (2013) conducted on medical and paramedical personnel at the Adam Moeloek General Hospital, which found 38.24% positive MRSA out of 68 samples taken by performing a nasal swab [9].

S. aureus is not only resistant to methicillin antibiotics but also already resistant to glycopeptide antibiotics, one of which is vancomycin. When *methicillin*-resistant *S. aureus is* found, the antibiotic of choice is a glycopeptide group, one of which is vancomycin. However, due to the continuous use of vancomycin, *S. aureus has* become resistant to vancomycin [8]. Since the first isolation of MRSA in the United Kingdom in 1961, the prevalence of MRSA has increased rapidly worldwide, and as a result, glycopeptide antibiotics have been relied on to treat MRSA infections. In 1996, in Japan, it was discovered that *S. aureus* infection had decreased susceptibility to vancomycin called Vancomycin Intermediate *S. aureus* (VISA). After that, about 20 cases of VISA infection were reported in several countries, including Korea. Furthermore, two isolates of VRSA were found in the United States in 2002 [20]. This trend suggests that in addition to MRSA, VRSA over the past two decades can be already widely found in many countries, including Indonesia [8].

Table 4: Multivariate analysis of risk factors for VRSA nasal colonization in health care workers

Variables	p	OR	95% CI	
			Min	Max
MRSA (+) history from another hospital				
Yes	0.058	0.160	0.02	1.06
Not				
Not doing hand rub/handwash				
Yes	0.082	6.10	0.79	46.96
Not				

CI: Confidence interval, Min-Max: Minimum–Maximum, OR: Odds ratio, VRSA: Vancomycin-resistant *Staphylococcus aureus.*

There were 6 (4.7%) subjects with positive VRSA from nasal swabs in this study. These results follow a study at Margono Soekarjo Hospital, Purwokerto, which stated that VRSA was found in ten of 64 isolates (15.6%) of stethoscope membranes (Anjarwati and Dharmawan, 2010). These results show that, currently, it is not only MRSA that is worrisome about but also VRSA. However, the mechanism of genetic and biochemical changes in *S. aureus* has not been fully explained and understood why it becomes resistant to vancomycin [8].

Risk factors for MRSA include environment, population, contact sports, personal hygiene, treatment history, surgery history, history of infection and disease, medication history, and medical conditions. Several factors that contributed significantly to increasing the incidence of MRSA were the influence of dose determination (90.4%), medication (90.2%), provision of antiseptics (84.9%), infusion cannula installation procedures (74.6%), and handwashing facilities (66.3%) [9]. In this study, the highest risk factors that cause nasal colonization of MRSA carrier of which is a history of previous positive MRSA in other hospitals (60%), history of infection in the ear nose throat (41.7%), and did hand rub/handwash (36.7%).

The proportion of MRSA in patients with skin and soft-tissue infections who underwent culture in the inpatient ward of Cipto Mangunkusumo Hospital was 47% (95% CI: 42–52%). Malignancy, the use of antibiotics class of quinolone, and invasive medical procedures (mainly the installation of central venous catheters, ventilator, and Foley urine catheter) are risk factors for MRSA skin and soft-tissue infections in the hospitalized patient. Age, male, diabetes mellitus, HIV-positive, the use of corticosteroids, the use of antibiotics class of beta-lactams and macrolides, injecting drug users, wards, as well as a history of hospitalization, are not proven as a factor risk of MRSA on skin infections and tissue software in the inpatient room [1].

Some risk factors for MRSA infections in patients in health facilities are patients in advanced age, the disease comorbidities (e.g., cardiovascular diseases, lung, or kidney diseases that are chronic, cancer, diabetes, anemia, and hyponatremia), the use of a mechanical ventilator, catheter venous central, previously treated, length of stay, intensive care unit stay, use of antibiotics before being treated, and the installation of a Foley urinary catheter [20].

Conclusion

As many as, 23.5% healthcare workers were found with nasal colonization of MRSA and 4.7% with

nasal colonization of VRSA. Accordingly, stricter policies are needed to minimize the transmission of these organisms from the hospital setting to the community. A positive MRSA history from another hospital and not doing hand rub/handwash significantly increased the risk of MRSA nasal colonization.

References

1. Putra MI, Suwarto S, Loho T, Abdullah M. Risk factors for *Methicillin-resistant Staphylococcus aureus* in patients with skin and soft tissue infections in inpatients. Indones J Intern Med. 2014;1(1):3-14.
2. Chen CJ, Huang YC. New epidemiology of *Staphylococcus aureus* infection in Asia. Clin Microbiol Infect. 2014;20:605-23. https://doi.org/10.1111/1469-0691.12705
   PMid:24888414.
3. Ghumman AH, Khan WM, Ilyas U, Kanwal A, Zahoor W, Baloch AH. Methicilin-resistant aureus (MRSA) and vancomycin-resistant *Staphylococcus aureus* (VRSA) nasal carriage in health care personnel and medical students of tertiary healthcare units. J Rawalpindi Med Coll Stud Suppl. 2016;20(S-2):72-6.
4. Suyasa, IBO and Mastra, N. Gambaran methilin resistant *Staphylococcus aureus* (MRSA) pada petugas kesehatan RSUD wangaya kota denpasar [Description of methilin resistant *Staphylococcus aureus* (MRSA) in health workers at wangaya hospital, Denpasar City]. Meditory. 2020; 8 (1): 46-52. Available from: http://ejournal.poltekkes-denpasar.ac.id/index.php/M
5. Lai CC, Chen SY, Ko WC, Hsueh PR. Increased antimicrobial resistance during the COVID-19 pandemic. Int J Antimicrob Agents. 2021;57(4):106324. https://doi.org/10.1016/j.ijantimicag.2021.106324
   PMid:33746045
6. Burhan E, Susanto AD, Isbaniah F, Nasution SA, Ginanjar E, Pitoyo CW, *et al*. Pedoman Tatalaksana COVID-19 Edisi 3 [Guidelines for the Management of COVID-19.3rd ed]. Jakarta, Indonesia: Indonesian Doctors Association; 2020.
7. Subramanya SH, Czyz DM, Acharya KP, Humphreys H. The potential impact of the COVID-19 pandemic on antimicrobial resistance and antibiotic stewardship. Virusdisease. 2021;32(2):330-7. https://doi.org/10.1007/s13337-021-00695-2
   PMid:34056051
8. Dwiyanti RD, Muhlisin A, Muntaha A. MRSA and VRSA: Paramedics at Ratu Zalecha hospital Martapura. Med Lab Technol J. 2015;1(1):27-33. https://doi.org/10.31964/mltj.v1i1.5
9. Maheasy R, Soleha TU, Ekowati CN. Identification of *Methicillin-resistant staphylococcus aureus* (MRSA) in medical and paramedical personnel in the intensive care unit (ICU) and surgical care unit at the Abdul Moeloek regional general hospital. Med J Lampung Univ. 2013;2(4):70-8.
10. Sharma Y, Jain S, Singh H, Govil V. *Staphylococcus aureus*: Screening for nasal carriers in a community setting with special reference to MRSA. Scientifica (Cairo). 2014;2014:479048. https://doi.org/10.1155/2014/479048
    PMid:5054078
11. Santosaningsih D, Santoso S, Verbrugh HA, Severin JA. Risk factors for *Methicillin-resistant staphylococcus aureus* carriage among patients at admission to the surgical ward in a resource-limited hospital in Indonesia. Am J Trop Med Hyg. 2017;97(5):1310-2. https://doi.org/10.4269/ajtmh.16-0993
    PMid:29016292
12. Ahmadi E, Khojasteh M, Mortazavi SM, Khan-Mohammadi F, Kazemnia A, Beheshtipour J, *et al*. Prevalence of and risk factors for *Methicillin-resistant staphylococcus aureus* nasal carriage in the west of Iran: A population-based cross-sectional study. BMC Infect Dis. 2019;19(1):899. https://doi.org/10.1186/s12879-019-4567-1
    PMid:31660878
13. Alzoubi H, Al Madadha M, Al-Mnayyis A, Azzam M, Aldawoud A, Hwaiti D, *et al*. Detection of methicillin susceptible and resistant *Staphylococcus aureus* nasal carriage and its antibiotic sensitivity among basic and clinical years medical students. Healthcare (Basel). 2020;8(2):161. https://doi.org/10.3390/healthcare8020161
    PMid:32517199
14. Ansari S, Gautam R, Shrestha S, Ansari SR, Subedi SN, Chhetri MR. Risk factors assessment for nasal colonization of *Staphylococcus aureus* and its methicillin resistant strains among pre-clinical medical students of Nepal. BMC Res Notes. 2016;9:214. https://doi.org/10.1186/s13104-016-2021-7
    PMid:27068121
15. Lekkerkerk WS, Haenen A, van der Sande MA, Leenstra T, de Greeff S, Timen A, *et al*. Newly identified risk factors for MRSA carriage in the Netherlands. PLoS One. 2017;12(11):e0188502. https://doi.org/10.1371/journal.pone.0188502
    PMid:29190731
16. Mondal H, Gupta I, Nandi P, Ghosh P, Chattopadhyay S, Mitra GD. Nasal screening of healthcare workers for nasal carriage of Methicillin Resistant *Staphylococcus aureus*, Vancomycin Resistant *Staphylococcus aureus* and prevalence of nasal colonization with *Staphylococcus aureus* in Burdwan Medical College and Hospital. Int J Contemp Med Res. 2016;3(11):3342-3346.
17. Planta PM, Laiño AG, Alqueza MN, Gonzales ML. Nasal carriage of *Staphylococcus aureus* among pediatric health care workers in a pediatric intensive care unit. J PIDSP. 2012;13(1):44-50.
18. Asri, RC, Rasyid, R. Edison. Identifikasi MRSA pada Diafragma Stetoskop di Ruang Rawat Inap dan HCU Bagian Penyakit Dalam [Identification of MRSA on the Stethoscope Diaphragm in the Inpatient Room and HCU Internal Medicine Department]. Andalas J Health. 2017;6(2):239-44. https://doi.org/10.25077/jka.v6i2.685
19. Tiwari HK, Sen MR. Emergence of vancomycin resistant *Staphylococcus aureus* (VRSA) from a tertiary care hospital from the northern part of India. BMC Infect Dis. 2006;6:156. https://doi.org/10.1186/1471-2334-6-156
    PMid:17067393
20. Dellit T, Duchin J, Hofmann J, Olson EG. Interim Guidelines for Evaluation and Management of Community Associated *Methicillin-resistant Staphylococcus Aureus* Skin and Soft Tissue Infection in Outpatient Settings. Washington: Infectious Diseases Society of Washington; 2004. p. 1-14.