



Methicillin-resistant *Staphylococcus aureus* antibiotic susceptibility profile and associated factors among hospitalized patients at Hawassa University Comprehensive Specialized Hospital, Ethiopia

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ABSTRACT

Introduction: Methicillin-resistant *Staphylococcus aureus* (MRSA) is a major cause of hospital-acquired infection, which is difficult to treat because of antibiotic resistance. There is scant data on MRSA from southern parts of Ethiopia.

Objective: The aim of this study was to determine the prevalence of MRSA nasal carriage, antibiotic susceptibility profiles, and associated factors among hospitalized patients attending Hawassa University Comprehensive Specialized Hospital (HUCSH), Hawassa, Ethiopia.

Methods: A hospital-based cross-sectional study was conducted from December 11, 2019 to February 15, 2020. Background and clinical data were captured by an interviewer-administered questionnaire. Nasal swabs were collected aseptically and inoculated onto mannitol salt agar and sheep blood agar, which was incubated for 24 hours at 37°C. *S. aureus* was confirmed using standard bacteriological methods. MRSA was identified using the cefoxitin Kirby-Bauer disk diffusion method.

Results: Of the 280 included hospitalized patients, 38 (13.6%) were colonized with *S. aureus*. The prevalence of MRSA carriage was 9.3% (95% CI 6.1–12.2). Twenty-six (68.4%) of the *S. aureus* isolates were methicillin resistant. Participants with a monthly income > 4000 Ethiopian Birr were four times more likely to be colonized with MRSA ($p = 0.022$). A high proportion of patients with a history of admission to the surgical ward was colonized with MRSA. Over 10% of MRSA isolates were resistant to all antibiotics except clindamycin and erythromycin. Of the 26 MRSA isolates, 88.5% showed multidrug resistance.

Conclusions: The prevalence of MRSA was relatively high among hospitalized patients at HUCSH. Factors such as weight and monthly income were significantly associated with the occurrence of MRSA.

Introduction

Staphylococcus aureus is a commensal bacterium that resides on wet parts of the skin and mucosal membrane, mainly in the anterior nares, of humans. If *S. aureus* is relocated to a sterile site of the body it can cause a localized or invasive systemic infection. Initially, *S. aureus* isolates were found to be susceptible to antibiotics that belong to the beta-lactam group; however, over time, they developed resistance to this group of antibiotics. The main mechanisms involved are beta-lactamase enzyme production and acquisition of the *mecA* gene (Saga and Yamaguchi, 2009). The beta-lactamase enzyme works by acting on the beta-lactam ring of antibiotics, rendering them ineffective, whereas the *mecA* gene codes for new types of penicillin-binding protein 2A (PBP2A) (Osman et al., 2019).

Methicillin was first introduced to human medicine in the 1960s for the treatment of infections caused by penicillin-resistant *S. aureus*; however, methicillin-resistant *S. aureus* (MRSA) emerged within a few years (Osman et al., 2019; Donkor et al., 2019). Complicating the problem, MRSA was found to be cross-resistant to all currently licensed β -lactam antibiotics (Donkor et al., 2019). The strain of *S. aureus* that is susceptible to methicillin is known as methicillin-susceptible *S. aureus* (MSSA). Because MRSA strains were originally isolated from healthcare settings, and are the main cause of nosocomial infection, they are referred to as healthcare-associated MRSA (HA-MRSA) (Oluwapelumi et al., 2018). Methicillin-resistant *S. aureus* strains from the community and livestock have also been described (Grema et al., 2015; Onanuga et al., 2019). MRSA can disseminate beyond the healthcare setting since there is no check for MRSA decolonization before patients are discharged from hos-

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pitals. Although the prevalence varies, MRSA is present in many parts of the world, including Europe, the USA, North Africa, the Middle East, and East Asia (Guo et al., 2010).

MRSA is the main cause of cutaneous and life-threatening deep-seated infections, which are difficult to treat with currently available antibiotics (Oluwapelumi et al., 2018). HA-MRSA can disseminate rapidly among hospitalized patients across healthcare facilities, impacting the existing treatment options for the management of staphylococcal infections (Osman et al., 2019). HA-MRSA is responsible for high levels of morbidity, mortality, and additional economic burden to the healthcare system (Kong et al., 2016). Evidence from high-income countries has indicated that implementing an effective infection control program in healthcare settings can significantly reduce the morbidity and mortality of MRSA-associated infections (Soe et al., 2021).

The nasopharyngeal carriage of MRSA can vary according to location, the segment of the population studied, and the study period. A high prevalence of MRSA — close to 47% — has been reported for Ethiopia (Deyno et al., 2017), compared with around 4% for Kenya (Omuse et al., 2012; Eshetie et al., 2016). Almost any item in contact with the skin can serve as a fomite in the dissemination of MRSA. MRSA can also persist within the home environment (Turner et al., 2017).

Although MRSA is important in terms of public health, there are limited data relating to MRSA carriage rates in Sidama regional state, Ethiopia. To control the spread of MRSA and to design new treatment options, monitoring the prevalence of MRSA over time is essential. Our study aimed to determine the prevalence of MRSA, the associated factors, and the antibiotic susceptibility profile of MRSA among hospitalized patients at Hawassa University Comprehensive Specialized Hospital (HUCSH), Sidama regional state, Ethiopia.

Materials and methods

Study design and area

A hospital-based cross-sectional study was conducted from December 11, 2019 to February 15, 2020 at HUCSH, which is located in Hawassa, the capital city of Sidama regional state. According to the 2016 estimate, the total population of the city is 315 267. HUCSH is a referral hospital, which provides various health-related services that are not managed at primary hospitals or other healthcare settings. The hospital has 350 beds to support its inpatient healthcare service.

Study population

Patients admitted (inpatients) to the medical, surgical, and gynecology wards of HUCSH for treatment during the study period, and who fulfilled the inclusion criteria, were taken as the study population.

Inclusion and exclusion criteria

Patients admitted to HUCSH during the study period, who were aged ≥ 18 , and who volunteered to participate in the study were included. Patients who were critically sick and who had nasal infections and bleeding at the time of data collection were excluded.

Sample size determination

The sample size was computed using a single population proportion formula based on a previous similar study (21%) (Heysell et al., 2011), a 0.05 margin of error, and a 95% confidence level. The total sample size after assuming a non-response rate of 10% was 280. A convenience sampling technique was applied to recruit study participants.

Data collection

A structured questionnaire adapted from another study was used to collect sociodemographic, behavioral, and clinical data. The ques-

tionnaire was administered by trained nurses using face-to-face interview. A nasal swab was collected aseptically using a normal saline-dipped sterile cotton swab. To collect specimens, the sterile swab was rotated 2–3 times inside the anterior nares of the study participants. Nasal swabs were inoculated onto mannitol salt agar and sheep blood agar and incubated at 37°C for 24 hours aerobically. *S. aureus* was identified by checking for yellow colonies on mannitol salt agar, colony characteristics on blood agar, and by performing catalase and coagulase tests. The slide coagulase-negative test was retested using the tube coagulase method. Colonies that appeared yellow on mannitol salt agar, showing as Gram-positive cocci, and that were catalase positive and coagulase positive, were considered to be *S. aureus*. Methicillin resistance was determined by ceftioxin (30 µg) antibiotic disk following the Kirby-Bauer disk diffusion method on Mueller–Hinton agar (MHA). *S. aureus* with a zone of inhibition diameter ≤ 21 mm was considered to be MRSA (CLSI, 2019).

Antibiotic susceptibility testing

Antibiotic susceptibility test (AST) was conducted using the modified disk diffusion method according to the CLSI guidelines (CLSI, 2019). Briefly, pure colonies of *S. aureus* isolates were suspended in 5 ml of sterile normal saline and compared with 0.5 McFarland standard. A sterile cotton swab was used to take samples from the suspension and uniformly inoculate them onto MHA. Within 2–15 minutes eight antibiotics, including penicillin, erythromycin, trimethoprim/sulfamethoxazole, tetracycline, ciprofloxacin, chloramphenicol, gentamicin, and clindamycin were placed on the MHA plates inoculated with test bacteria and incubated at 37°C for 16–18 hours. After overnight incubation, the zones of inhibition were measured by caliper and compared with the standard, and interpreted as susceptible (S), intermediate (I), or resistant (R).

Data quality control

The suitability of the questionnaire was checked by collecting data from a population representing 10% of the sample size. Data were analyzed and the questionnaire was modified based on the pretest analysis. The performance of culture media was evaluated using known reference strains, such as *S. aureus* (ATCC 25923), *S. epidermidis* (ATCC 12228), *S. pneumoniae* (ATCC 49619), *Streptococcus pyogenes* (ATCC 19615), and *E. coli* (ATCC 25922). Sterility of culture media was checked by incubating 5% of it at 37°C for 24 hours without inoculation.

Data analysis

After checking for completeness and consistency, captured data were entered onto SPSS version 23 for analysis. Descriptive statistics were used to summarize the sociodemographic, behavioral, and clinical profiles of the study participants. Bivariate and multivariate logistic regressions were used to determine risk factors for MRSA colonization. Variables with a p -value < 0.2 in bivariate analysis were further analyzed by multivariable logistic regression. A p -value ≤ 0.05 was set as the cut point to establish a significant association between factors and the occurrence of MRSA.

Operational definitions

Methicillin-resistant *S. aureus* (MRSA): *S. aureus* with a zone of inhibition ≤ 21 mm for ceftioxin or oxacillin on MHA after 16–18 hours of incubation (CLSI, 2019).

Multidrug-resistant (MDR): MRSA that is resistant to \geq three antibiotics belonging to different classes.

Table 1

Sociodemographic characteristics of hospitalized patients at Hawassa University Comprehensive Specialized Hospital, Sidama regional state, Ethiopia, December 11, 2020 to February 15, 2021 ($N = 280$).

Variables	Category	Frequency (%)
Gender	Female	132 (47.1)
	Male	148 (52.9)
Age in years	18–28	93 (32.2)
	29–39	69 (24.6)
	40–49	47 (16.8)
	50–59	22 (7.9)
	≥ 60	49 (17.5)
Education	No formal education	79 (28)
	Grade 1–12	181 (65)
	Higher education	20 (7)
Occupation	House wife	92 (32.9)
	Government employee	37 (13.2)
	Merchant	19 (6.8)
	Student	35 (12.5)
	Farmer	65 (23.2)
	Others	32 (11.4)
Weight in kilograms	40–59	113 (40.4)
	60–79	156 (55.7)
	80–99	11 (3.9)
Monthly income in ETB	No income	30 (10.7)
	1–4000	200 (71.4)
	4001–8000	33 (11.8)
	> 8000	17 (6.1)
Family size in number	1–4	90 (32.1)
	5–8	140 (50)
	9–12	42 (15)
	> 12	8 (2.9)

ETB: Ethiopian Birr.

Results

Sociodemographic and clinical characteristics

In total, 280 hospitalized patients were involved in this study. The ages of the participants ranged from 18–86 years, with a mean (\pm standard deviation) of 39.74 ± 16.5 ; 132 (47.1%) were females and 79 (28.2%) had no formal education (Table 1). Of the 280 participants, 23.6%, 53.9%, and 22.5% were admitted to the medical, surgical, and gynecology wards, respectively. Forty-eight (17.1%) of the participants had a family member who worked in a health facility, while 61 (21.8%) had a history of hospitalization in the past year. Most participants had a family size of 5–8 and 19 (6.8%) participants had scratches caused by self lanced boils lancing boil (Table 2).

Prevalence of MRSA

Thirty-eight *S. aureus* isolates were identified from the nasal cavities of the 280 admitted patients, giving a prevalence of 13.6%. The prevalence of MRSA among admitted adult patients was 26/280 (9.3%; 95% CI 6.1–12.2). Of the 38 *S. aureus* isolates, 26 (68.4%) were identified as MRSA.

Factors associated with the prevalence of MRSA

Among the different factors assessed, monthly income and weight of participants were significantly associated with the occurrence of MRSA. Participants with a monthly income > 4000 ETB were four times more likely to be colonized with MRSA ($p = 0.022$). Most participants with a history of admission and participants with a family size greater than four were colonized with MRSA (Table 3).

Table 2

Assessment for nasal colonization of *S. aureus* among patients admitted to Hawassa University Comprehensive Specialized Hospital, Sidama regional state, Ethiopia, December 11, 2020 to February 15, 2021 ($N = 280$).

Variables		n (%)
Hospitalized family member	Yes	27 (9.6)
	No	253 (90.4)
Current respiratory tract	Yes	56 (20)
	No	224 (80)
Scratch by inpatients lancing boils with fingernails	Yes	19 (6.8)
	No	261 (93.2)
Antibiotics use in the past 4 weeks	Yes	120 (42.9)
	No	160 (57.1)
Number of family members	1–4	90 (32.)
	5–8	140 (50)
	9–12	42 (15)
	> 12	8 (2.9)
History of hospitalization in the past year	Yes	61 (21.8)
	No	219 (78.2)
If yes for the above question, to which ward they were admitted	Medical	22 (7.9)
	Surgical	22 (7.9)
	Gynecology	17 (6.1)
Family member who works in health institution	Yes	48 (17.1)
	No	232 (82.9)
Use of percutaneous medical device in the past one year	Yes	106 (37.9)
	No	174 (62.1)
Admission ward at this time	Medical	66 (23.6)
	Surgical	151 (53.9)
	Gynecology	63 (22.5)
Number of patients admitted in the ward (room) to which they were admitted	1–5	170 (60.7)
	6–10	110 (39.3)

Antibiotic susceptibility profile

Of the total *S. aureus* isolates ($n = 38$), 94.7%, 68.4%, and 57.9% were resistant to penicillin, trimethoprim/sulfamethoxazole, and ciprofloxacin, respectively, whereas 94.7%, 86.8%, and 73.7% were susceptible to clindamycin, chloramphenicol, and gentamicin, respectively. Of the 26 MRSA isolates, 76.9% and 38.5% were resistant to trimethoprim/sulfamethoxazole and ciprofloxacin, respectively (Table 4). Twenty-seven (71.1%) *S. aureus* isolates showed multidrug resistance (Table 5).

Discussion

S. aureus is a normal inhabitant of the nasal cavity of humans. It is the main cause of hospital-acquired infection, and its management is complicated because of antibiotic resistance, especially to the beta-lactam group. Our study revealed a relatively low prevalence of *S. aureus* (13.6%) among hospitalized patients at HUCSH, in contrast with other studies that have reported *S. aureus* carriage rates of > 15% (Mohajeri et al., 2013; Heininger et al., 2007; Morange-Saussier et al., 2006). The difference observed could be due to sociodemographic factors, the clinical background of participants, or the pattern of antibiotic use. Our study identified a relatively high prevalence of MRSA (9.3%), which was comparable to rates reported for Jimma, Ethiopia (8.4%) (Efa et al., 2019) and India (8.6%) (Bhaskaran et al., 2014), but was higher than the prevalences of MRSA reported for high-income countries such as The Netherlands (0.13%) (Weterings et al., 2019), the USA (0.8%) (Kuehnert et al., 2006), Germany (2.1%) (Heckel et al., 2017), Ireland (2.7%) (Crawford et al., 2020), and Iran (6.5%) (Mohajeri et al., 2013). In contrast to our results, high prevalences of MRSA have been reported from Addis Ababa, Ethiopia (12.1%) (Kubi et al., 2018), South Africa (21%) (Heysell et al., 2011), and Iran (20%) (Moniri et al., 2009). The high prevalence of MRSA observed in our study could be due to the frequent use of antibiotics in hospitals. MRSA can also be acquired from

Table 3

Bivariate and multivariate analysis of factors associated with MRSA among hospitalized patients at Hawassa University Comprehensive Specialized Hospital, Sidama regional state, Ethiopia, December 11, 2020 to February 15, 2021.

Variables	Category	MRSA, n (%)		COR (95% CI)	p-value	AOR (95% CI)	p-value
		Positive	Negative				
Age in years	18–27	6 (6.5)	87 (93.5)	1			
	> 27	20 (10.7)	167 (89.3)	1.74 (0.673–4.48)	0.254	1.06 (0.32–3.54)	0.92
Sex	Male	12 (8.1)	136 (91.9)	1			
	Female	14 (10.6)	118 (89.4)	1.35 (0.598–3.02)	0.473	0.22 (0.043–1.13)	0.070
Monthly income in ETB	< 4000	15 (6.5)	215 (93.5)	1			
	≥ 4000	11 (22)	39 (78.0)	0.25 (0.106–0.578)	0.001	4.04 (1.22–13.35)	0.022
Weight of patients in kilograms	40–59	7 (6.2)	106 (93.8)	0.30 (0.05–1.65)	0.165	0.054 (0.004–0.700)	0.026
	60–79	17 (10.9)	139 (89.1)	0.55 (0.11–2.76)	0.468	0.112 (0.010–1.239)	0.074
	80–99	2 (18.2)	9 (81.8)	1			
Family size	1–4	4 (4.4)	86 (95.6)	1			
	> 4	22 (11.6)	168 (88.4)	2.82 (0.94–8.43)	0.05	2.1 (0.82–6.01)	0.045
Presence of RTI	Yes	6 (10.7)	50 (89.3)	1.22 (0.47–3.21)	0.681	1.41 (0.332–5.94)	0.644
	No	20 (8.9)	204 (91.1)	1			
Presence of lanced boil	Yes	2 (10.5)	17 (89.5)	1.16 (0.25–5.33)	0.847	1.04 (0.07–14.78)	0.978
	No	24 (9.2)	237 (90.8)	1			
Antibiotic taken within the last 4 weeks	Yes	10 (8.3)	110 (91.7)	1			
	No	16 (10.0)	144 (90.0)	1.22 (0.53–2.80)	0.635	3.97 (0.125–12.7)	0.118
History of hospitalization in the last year	Yes	10 (16.4)	51 (83.6)	1			
	No	16 (7.3)	203 (92.7)	2.49 (1.07–5.81)	0.035	15.2 (0.49–470.53)	0.120
Admission ward within the last year	Not admitted	18 (8.2)	201 (91.8)	0.67 (0.142–3.17)	0.615	20.2 (0.43–943.7)	0.126
	Medical	2 (9.1)	20 (90.9)	0.75 (0.096–0.95)	0.785	0.64 (0.045–9.19)	0.743
	Surgical	4 (18.2)	18 (81.8)	1.67 (0.27–10.4)	0.584	12.2 (0.98–152.38)	0.05
	Gynecology	2 (11.8)	15 (88.2)	1			
Healthcare worker in the family	Yes	3 (6.2)	45 (93.8)	1			
	No	23 (9.9)	209 (90.1)	1.65 (0.48–5.74)	0.430	0.45 (0.092–2.2)	0.327
Number of patients in admitted room	1–5	20 (11.8)	150 (88.2)	2.31 (0.90–5.95)	0.083	3.4 (0.92–12.52)	0.066
	6–10	6 (5.5)	104 (94.5)	1			
Medical device usage	Yes	12 (11.3)	94 (88.7)	1.46 (0.65–3.29)	0.362	36 (0.09–1.42)	0.144
	No	14 (8.0)	160 (92.0)	1			
Current ward in which patient is admitted	Medical	6 (9.1)	60 (90.9)	1.06 (0.39–2.93)	0.908	0.626 (0.12–3.25)	0.578
	Gynecology	7 (11.1)	56 (88.9)	1.33 (0.503–3.50)	0.568	0.38 (0.063–2.32)	0.296
	Surgical	13 (8.6)	138 (91.4)	1			
Length of admission	< 14 days	25 (9.7)	233 (90.3)	2.25 (0.29–17.47)	0.437	2.7 (0.21–34.6)	0.446
	≥ 14 days	1 (4.5)	21 (95.5)	1			

Table 4

Antibiotic susceptible profile of methicillin-resistant *S. aureus* isolated from the hospitalized patients at Hawassa University Comprehensive Specialized Hospital, Sidama regional state, Ethiopia, December 11, 2020 to February 15, 2021.

Antibiotics tested	All <i>S. aureus</i> , n = 38			MRSA, n = 26		
	S, n (%)	I, n (%)	R, n (%)	S, n (%)	I, n (%)	R, n (%)
Penicillin	2 (5.3)	–	36 (94.7)	–	–	26 (100)
Erythromycin	11 (28.9)	25 (65.8)	2 (5.3)	3 (11.5)	21 (80.8)	2 (7.7)
Trimethoprim/ Sulfamethoxazole	12 (31.6)	–	26 (68.4)	6 (23.1)	–	20 (76.9)
Tetracycline	16 (42.1)	–	22 (57.9)	8 (30.8)	–	18 (69.2)
Ciprofloxacin	26 (68.4)	2 (5.3)	10 (26.3)	14 (53.8)	2(7.7)	10 (38.5)
Chloramphenicol	33 (86.8)	–	5 (13.2)	21 (80.8)	–	5 (19.2)
Gentamicin	28 (73.7)	2 (5.3)	8 (21)	16 (61.5)	2 (7.7)	8 (30.8)
Clindamycin	36 (94.7)	2 (5.3)	–	23 (88.5)	3 (11.5)	–

Table 5

Multidrug-resistance profile of *S. aureus* (n = 38) and methicillin-resistant *S. aureus* (n = 26) isolated from hospitalized patients at Hawassa University Comprehensive Specialized Hospital, Sidama Regional State, Ethiopia, December 11, 2020 to February 15, 2021.

<i>S. aureus</i> (n = 38)	Resistance pattern for antibiotic, n (%)								
	R1	R2	R3	R4	R5	R6	R7	R8	MDR (≥3)
MSSA (n = 12)	6 (50)	2 (16.7)	4(33.3)	–	–	–	–	–	4 (33.3)
MRSA (n = 26)	2 (7.7)	1 (3.9)	5 (19.2)	7 (29.9)	4 (15.4)	4 (15.4)	2 (7.7)	1 (3.9)	23 (88.5)
Total (n = 38)	8 (21.1)	3 (7.9)	9 (23.7)	7 (18.4)	4 (11.1)	4 (11.1)	2 (5.3)	1 (2.6)	27 (71.1)

MSSA: methicillin-susceptible *S. aureus*, MRSA: methicillin-resistant *S. aureus*.

R1, R2, R3, R4, R5, R6, R7, and R8: resistant to one, two, three, four, five, six, seven, and eight antibiotics tested, respectively.

Multidrug-resistant refers to a bacterium that is resistant to ≥ 3 different classes of antibiotic.

healthcare workers during medical interventions. The variation in the prevalence of MRSA across these countries indicates a disparity in the control measures applied.

Of the 38 *S. aureus* isolates, 26 (68.4%) were MRSA, which was higher than the proportion of MRSA reported from other parts of Ethiopia (32.5%) (Eshetie et al., 2016), southern Ethiopia (40.2%) (Daka, 2014), Assam (34.78%) (Saikia et al., 2009), and Iran (36.8%) (Mohajeri et al., 2013). In contrast to our findings, a study from Jimma, Ethiopia reported a low proportion of MRSA (8.3%) (Gebre-Sealssie et al., 2007). On the other hand, two other studies from Ethiopia — Jima (Godebo et al., 2013) and Bahirdar (Abera et al., 2008) — indicated high MRSA proportions of 76.7% and 54.9%, respectively. The variation observed could be due to the source of bacteria, the nature of the study participants, the laboratory methods used, and the study methods applied.

Most factors assessed in our study were not significantly associated ($p > 0.05$) with the occurrence of MRSA. However, monthly income was significantly associated with the occurrence of MRSA. Participants with a monthly income > 4000 ETB were four times more likely to be colonized with MRSA ($p = 0.022$). This might be due to the high tendency for self-medication without formal prescription among participants with high incomes. There was also a high proportion of MRSA carriers among participants with a family size > 4 , which may indicate the possibility of acquiring MRSA from a family member; however, this should be confirmed by conducting a study that includes both hospitalized MRSA carriers and their family members. Most participants who had a history of admission to the surgical ward in the previous year were colonized with MRSA. Similar findings have been reported from Ethiopia and Pakistan (Gebremedhn et al., 2016; Moniri et al., 2009).

The majority of MRSA isolates in our study were resistant to trimethoprim/sulfamethoxazole (76.9%), tetracycline (69.6%), ciprofloxacin (38.5%), and gentamicin (30.8%). Similarly, all MRSA isolates from a study in Dessie, Ethiopia were found to be resistant to penicillin, whereas 84.8% of all *S. aureus* isolates were resistant to penicillin (Tsige et al., 2020). In contrast to our results, most MRSA isolates from Dessie, Ethiopia were found to be resistant to gentamicin (53.8%) and ciprofloxacin (61.5%) (Tsige et al., 2020).

None of the *S. aureus* isolates recovered in our study was resistant to clindamycin. However, other studies conducted in Ethiopia have reported high prevalences of clindamycin-resistant MRSA ranging from 7–17.1% (Tsige et al., 2020; Mamo et al., 2020). Moreover, a high clindamycin-resistant MRSA rate of 58.5% was reported from Iran (Mohajeri et al., 2013). In our study, 7.7% of MRSA isolates were resistant to erythromycin, which was lower than the prevalences reported for Jima (29.1%) (Efa et al., 2019) and by Bhaskaran et al. (30%) (Bhaskaran et al., 2014).

In comparison with our results, a lower rate of trimethoprim/sulfamethoxazole resistance was reported from India (Bhaskaran et al., 2014), while a higher prevalence of chloramphenicol-resistant MRSA was reported from Iran (Mohajeri et al., 2013). Our results showed an MDR prevalence of 88.5% among MRSA isolates, which was higher than those report from Iran (80.5%) (Mohajeri et al., 2013) and Assam (34.78%) (Saikia et al., 2009). The high proportion of antibiotic resistance observed our study could be due to the extensive use of antibiotics to treat infection caused by *S. aureus* without appropriate prescription.

Limitations of the study

Our study did not determine vancomycin resistance. Since we used a convenient sampling technique, selection bias might have been introduced. Given that this study was institution based, the findings cannot be generalized. Finally, during data collection, the participants may not have remembered the answers to all questions asked, which might have led to recall bias.

Conclusions

Our study showed a relatively high prevalence of MRSA in hospitalized patients. Among the factors assessed, monthly income was significantly associated with the colonization rate of MRSA. Most MRSA isolates were resistant to tetracycline and trimethoprim/sulfamethoxazole. A large proportion of the MRSA isolates were MDR.

Abbreviations

HUCSH: Hawassa University Comprehensive Specialized Hospital, MRSA: Methicillin-resistant *S. aureus*, MHA: Mueller–Hinton agar

Ethical approval and consent to participate

This study was ethically cleared by the Institutional Review Board of the College of Medicine and Health Sciences, Hawassa University (IRB/201/12). Permission letters were obtained from the study sites. Written informed consent was sought before data collection.

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Conflicts of interest

The authors have declared that no competing interests exist.

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Availability of data and materials

All relevant data are available within the paper.

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