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Methicillin and vancomycin-resistant *Staphylococcus aureus* and associated risk factors among patients with wound infection in East Wallaga Zone, Western Ethiopia

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SUMMARY

Background: Methicillin and vancomycin-resistant *S. aureus* have become increasingly problematic in recent years. This may be explained by the indiscriminate use of this antibiotic. The aim of this study was to determine the prevalence of methicillin-resistant and vancomycin-resistant *Staphylococcus aureus* (VRSA) and associated risk factors in patients with wound infections in the East Wallaga Zone, Western Ethiopia.
Methods: A hospital-based cross-sectional prospective study was conducted on 384 patients with wound infections including surgical wound who sought healthcare at Nekemte Specialized Hospital. Wound samples were collected using aseptic techniques and cultured on blood agar and mannitol salt agar. Vancomycin E-test and cefoxitin (30 μg) antibiotic disc diffusion were used to detect MRSA and VRSA, respectively. Data were analyzed using SPSS version 23, and a *P*-value of less than 0.05 was considered statistically significant.
Results: Of the 384 wound samples collected, 109 (28.4%) were identified as *Staphylococcus aureus*. Of these, 40.4% (44/109) were identified as MRSA, and 7.3% (8/109) were VRSA. Thirty-two (72.7%) MRSA isolates were showed multidrug resistance. The depth of the wound, patient setting, history of wound infection, and history of antibiotic use became significantly associated with the prevalence of MRSA wound infection.
Conclusions: This study found significant levels of *S. aureus*, MRSA, and VRSA in patients with wound infection. Therefore, it is crucial to implement effective infection prevention and control measures to prevent the spread of antimicrobial resistance.

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Introduction

Wound infections are a serious health problem. They claim the lives of many individuals every day yet are both curable and potentially preventable. Wound infections are of concern in hospitals, especially following surgical procedures where clean operations may be compromised by pathogenic organisms and subsequently infected. Additionally, it is possible for people in some countries to buy antibiotics without a prescription, which encourages widespread antibiotic overuse and aids in the development and spread of antimicrobial resistance [1].

Staphylococcus aureus is a significant human pathogen that can cause a wide range of infections, from minor skin infections to more severe and invasive infections like septicemia, pneumonia, infective endocarditis, deep-seated abscesses, and diseases brought on by toxins like toxic shock syndrome and food poisoning. Methicillin-resistant *S. aureus* (MRSA), is an important pathogen and is a frequent cause of postoperative wound infections [2,3].

Many people are affected by antimicrobial resistance (AMR), which occurs worldwide. Antimicrobial resistance (AMR), according to the WHO, poses threat to global health and development and is increasing. The emergence of new resistance mechanisms, inappropriate antibiotic usage, notably the overprescribing of antibiotics by medical professionals and the abuse of antibiotics by the public, all contribute to the problem. The treatment of various diseases is growing more challenging as a result of AMR [4].

Vancomycin-resistant *Staphylococcus aureus* (VRSA) and MRSA are causes of both community and hospital-associated infections globally [5]. In all WHO areas, MRSA prevalence was reported to be higher than 20%, while a national report from nine African countries revealed a prevalence range of 12%–80% [6]. VRSA prevalence in Africa as a whole was estimated to be 2.5 percent [7]. Public health issues in Ethiopia include MRSA and VRSA, with MRSA prevalence ranging from 28.3% in Dessie [8] to 82.3% in Arba Minch [9] while VRSA varies from 5.6% in Addis Ababa [10] to 14.1% in Debre Markos [3].

Because antibiotic-resistant bacteria are common, improvements in infection management have not eliminated these issues. Wound infections are made worse by the emergence of bacterial pathogens that are resistant to antibiotics due to widespread and prolonged antibiotic use and subsequent increases in morbidity and mortality. The difficulties and costs of healthcare procedures and treatments may rise as a result of antimicrobial resistance [11].

Despite several research projects about the microbiological causes of wound infections in Ethiopia having been carried out, none of them have sufficiently addressed the extent of MRSA and VRSA, particularly in the current study area of Ethiopia. Awareness of the bacterial agents likely to be causing wound infections is useful for choosing appropriate empirical therapy, informing infection prevention and control practices in healthcare settings, and developing evidence to support antibiotic policy [5]. The objective of this study was to identify the prevalence of methicillin-resistant and vancomycin-resistant *Staphylococcus aureus* and the related risk factors among patients with wound infections in the East Wallaga Zone, Western Ethiopia.

Methods

Study location, design, and population

The research was done at Nekemte Specialized Hospital (NHS), East Wallaga Zone, in the Oromia Regional State, Western Ethiopia. The hospital is in Nekemte Town, which is 328 km from Ethiopia's capital, Addis Ababa. The East Wallaga, West Wallaga, Kellem Wallaga, Horro Guduru, and Bunno Bedelle zones are the five zones that the hospital serves, along with one neighboring region (Benishangul Gumuz). It caters to almost two million people. With over three hundred beds, the hospital comprises 17 departments.

A hospital-based cross-sectional prospective study was conducted on wound samples from November 2020 to April 2021. The sample size was calculated by using single proportion formula. A 95% confidence interval was used, a 5% margin of error and prevalence of 50%, since there were no published previous studies conducted in this area of Ethiopia. The sample size was calculated as 384. Samples were collected from 384 patients admitted to different wards of the hospital and the outpatient department of Nekemte Specialized Hospital (NSH). Patients currently being treated with antibiotics were excluded as the ongoing antibiotic treatment may have reduced the number of antibiotic-resistant bacteria present and this could potentially skew the results of the study by underestimating the prevalence of antibiotic-resistant bacteria in the population.

Data collection

Information related to risk factors from patients was collected by nurses using a pre-tested questionnaire guided interview. The wound's immediate surface was first cleaned with 70% alcohol moistened on sterile gauze. According to Levine and Gardner's method, fluid contain bacteria were released from the wound tissue by rotating the end of a sterile cotton-tipped applicator over a 1 cm^2 area for 5 seconds while applying pressure. A 0.5 ml volume of sterile normal saline solution was added to the sterile test tubes when collecting the specimens. Conventional microbiological methods for bacterial culture, identification and susceptibility testing were conducted [12].

Culture and identification

Each wound specimen was inoculated on blood agar and MacConkey agar. The plates were incubated for 24–48 hours at 37 $^{\circ}$C. Gram stain analysis and the pattern of biochemical responses were used to examine each growing bacterial colony. The typical yellow colony surrounded by a yellow zone on mannitol salt agar, hemolytic colonies with yellowish pigment on blood agar, clusters of Gram-positive cocci, catalase and coagulase production, and mannitol fermentation were used to identify *S. aureus*.

Antimicrobial susceptibility test

To determine antibiotic resistance, ten antibiotics were tested against the *S. aureus* isolates. A test for antibiotic susceptibility was conducted using the disc diffusion technique on Muller Hinton agar (MHA). A tube containing 5 ml of sterile nutrient broth was filled with 3–5 pure colonies of each bacterium. To standardise the size of the inoculum, the suspension was incubated at 37 °C until the turbidity was brought to a 0.5 McFarland turbidity standard.

The MHA plate's whole surface was uniformly inoculated with the suspension using a sterile swab, and then the suspension was allowed to dry. The antimicrobial-impregnated discs were positioned on the media 24 mm apart from the others. The plates were incubated at 37 °C for 24 hrs, and zone of inhibition was observed by comparing with standards following the disc manufacturer's guideline. The diameter of the zone of inhibition around the disc was measured to the nearest millimeter using a ruler, and the isolates were classified as sensitive and resistant using Clinical Laboratory Standards Institute standard. The minimal inhibitory concentration (MIC) for the detection of VRSA was established by applying an E-test strip to the inoculated MHA. The breakpoints of MIC were measured and determined following 16–18 hrs of incubation at 35–37 °C based on Clinical Laboratory Standards Institute standard [12]. Bacteria were classified as multidrug resistant in the current study if they were resistant to three or more antibiotics belonging to different classes.

Quality control

Standard operating procedures were closely adhered to during all stages of quality assurance. Questionnaire was pretested. By incubating 5% of the batch at 35–37 °C for an overnight period, the sterility of the culture media was examined for any potential contamination. To ensure the performance of the testing of the potency of the antimicrobial discs, the standard reference bacteria strains, such as *S. aureus* (ATCC 25923), were tested on a weekly basis as controls on the biochemical tests and agar plates, including Mueller Hinton agar with antimicrobial discs. A 0.5% McFarland standard was used to uniformly measure the bacterial suspension's inoculum density for the susceptibility test. Senior laboratory personnel also checked the entire process and result interpretation.

Data analysis

Data were collected, summarised, tabulated, and analysed using Statistical Package Epi-Info™ Version 7 and SPSS™ Version 23 software. A statistically significance association was measured by using bivariate and multivariate logistic regression. Bivariate logistic regression analysis with a *P*-value cutoff of less than 0.2 was used to first determine a crude association between the independent variable and MRSA. In multi-variable logistic regression analysis, the associated factors of MRSA were further assessed at a cut point of a *P*-value less than 0.05. An odds ratio at the 95% confidence interval (*P*-value < 0.05) was considered statistically significant.

Results

Socio-demographic and clinical characteristics of patients

A total of 384 patients with wound infections were included in this study, of whom the majority were male (65%). The age of study participants ranges from 1-79 years, with mean (±

Table I
Socio-demographic and clinical characteristics of patients with wound infection at NSH

Variables	Characteristics	Frequency (N)	Percentage (%)
Gender	Male	251	65.4
	Female	133	34.6
Age (years)	<15	73	19.1
	15–30	153	39.8
	31–45	88	22.9
	46–60	52	13.5
	>60	18	4.7
Education status	No formal education	102	26.6
	Grade 1-12	246	64.1
	Higher education	36	9.0
Occupation	Government	79	20.6
	Housewife	102	26.6
	Farmer	86	22.4
	Daily labourer	70	18.2
	Merchant	27	7.0
	Student	20	5.2
Marital status	Married	198	51.6
	Single	115	29.9
	Widowed	37	9.6
	Divorced	34	8.9
Residence	Urban	199	51.8
	Rural	185	48.2
Patient setting	Inpatient	106	27.6
	Outpatient	278	72.4
Site of infection	Leg	118	30.7
	Feet	79	20.6
	Hand	62	16.2
	Head and neck	60	15.6
	Back and abdomen	53	13.8
	Other	12	3.1
Type of wound	Surgical wound	108	28.1
	Non-healing ulcer	66	17.2
	Burn wound	38	9.9
	Trauma	148	38.5
	Other (Abscess)	24	6.3
Cause of wound	Burn	57	14.8
	Surgery	129	33.6
	Gun Shot	13	3.4
	Bite	14	3.7
	Injury	159	41.4
	Other	12	3.1
Wound depth	Deep	240	62.5
	Superficial	144	37.5
History of hospitalisation in the last 6 months	Yes	65	16.9
	No	319	83.1
History of wound infection in the last 6 months	Yes	77	20.1
	No	307	79.9
History of antibiotic use in the last 6 months	Yes	165	43.0
	No	219	57.0
Co-morbidity	Yes	53	13.8
	No	331	86.2

Table II
Antibiotic susceptibility pattern of *S. aureus* and MRSA from wound infection at NSH

Antibiotics	*S. aureus*, n=109			MRSA, n=44		
	S n (%)	I n (%)	R, n (%)	S n (%)	I n (%)	R n (%)
Cefoxitin	65 (59.6)	0	44 (40.4)	0	0	44 (100)
Chloramphenicol	88 (80.7)	3 (2.8)	18 (16.5)	27 (61.5)	2 (4.5)	15 (34)
Clindamycin	94 (86.2)	0	15 (13.8)	33 (75)	0	11 (25)
Ciprofloxacin	61 (56)	0	48 (44)	24 (54.5)	0	20 (45.5)
Cotrimoxazole	95 (87.2)	0	14 (12.8)	26 (59.1)	0	18 (40.9)
Erythromycin	95 (87.2)	2 (1.8)	12 (11)	32 (79.6)	2 (4.5)	10 (15.9)
Gentamicin	86 (78.9)	3 (2.8)	20 (18.3)	28 (63.6)	0	16 (36.4)
Penicillin	7 (6.4)	0	102 (93.6)	0	0	44 (100)
Tetracycline	55 (50.5)	9 (8.2)	45 (41.3)	15 (34)	4 (9.1)	25 (56.8)
Vancomycin	98 (89.9)	3 (2.7)	8 (7.4)	40 (90.9)	0	4 (9.1)

S: sensitive, I: intermediate, R: resistant.

Table III
Multidrug-resistance profile of *S. aureus* and methicillin-resistant *S. aureus* isolated from wound infection at NSH

Bacterial isolate	Resistance pattern for antibiotic, n (%)								MDR (≥3)
	R0	R1	R2	R3	R4	R5	R6	R7	
MRSA (n=44)	0	2 (4.5)	9 (20.5)	6 (13.6)	7 (15.9)	4 (9.1)	14 (31.8)	1 (2.3)	32 (72.7)
S. aureus (n=109)	7 (6.4)	43 (39.4)	16 (14.7)	6 (5.5)	8 (7.3)	4 (3.7)	14 (12.8)	1 (0.9)	33 (30.3)

Abbreviations: R0, R1, R2, R3, R4, R5, R6, sensitive to all, resistance to one, two, three, four, five, and greater than six antibiotics tested, respectively; MDR (≥3): multidrug resistance (for greater than or equal to three antibiotics); MRSA: methicillin-resistant *Staphylococcus aureus*.

standard deviation) of 42.21±12.7 years. More than half of the participants, 246 (64.1%), were in grade 1–12, 199 (51.8%) lived in urban area, 198 (51.6%) were married, and 278 (72.4%) were outpatients (Table I). Regarding clinical characteristics, the majority (62.5%) of the study participants had deep wounds. One hundred eighteen (30.7%) study subjects had wound infections on their legs, followed by 20.6% on their feet and 16% on their hands. Most wound infections (41.4%) were caused by injury, followed by surgery (33.6%) and burns (14.8%). A history of antibiotic use was experienced by 47% of patients with wound infections (Table I).

Prevalence of S. aureus, MRSA, and VRSA

The rate of isolation of *S. aureus* wound infection was 28.4% (109/384, 95% CI: 23.7%–33.1%), while the prevalence of MRSA and VRSA among the isolates was 40.4% (44/109, 95% CI: 33.1%–47.7%) and 7.3% (95% CI: 4.2%-10.4 %), respectively.

Antibiotic resistance patterns of S. aureus and MRSA

S. aureus showed the highest resistance against penicillin (100%). MRSA exhibited the highest rate of resistance against tetracycline (56.8%) compared with other antibiotics. MRSA resistance against other antibiotics was also shown in the present for ciprofloxacin (45.5%), cotrimoxazole (40.9%), gentamicin (36.4%), chloramphenicol (34%), clindamycin (25%), erythromycin (15.9%), and vancomycin (9.1%) (Table II).

Multidrug resistance pattern of MRSA

Out of the 109 *S. aureus* isolates, 7 (6.4%) of them were sensitive to all antibiotics tested. Thirty-three (30.3%) of *S. aureus* isolates showed multidrug resistance. From a total of 44 MRSA isolates, 32 (72.7%) of them showed multidrug resistance (Table III).

Factors associated with MRSA and VRSA

Based on bivariate logistic regression analysis gender, residence, wound depth, patient setting, use of traditional medicine, history of wound infection, and antibiotics in the last 6 months was selected for multivariable logistic regression (Table IV).

In multivariable logistic regression analysis, the depth of the wound (AOR = 4.63; 95% CI: 1.03–20.90), patient setting (AOR = 4.38; 95% CI: 1.05–18.29), history of wound infection (AOR = 3.81; 95% CI: 1.23–11.82), and history of antibiotic use in the last 6 months (AOR=3.81; 95% CI: 1.23–11.82) became significantly associated with the prevalence of MRSA (Table IV). The present study revealed lack of correlation between factors and VRSA.

Discussion

In the current study, the rate of isolation of *S. aureus* wound infections was 28.4% (109/384, 95% CI: 23.7%–33.1%). This result is consistent with the research done in Metu, Ethiopia, which was 32.8% [13], 29.3% in Debre Markos, Ethiopia, by Teferal *et al.* [3], 32.1 percent in Debre Markos by Shimekaw *et al.* [14], 27% in Nigeria [15] and 26.6% in Cameron [16]. However, it is lower than the national pooled prevalence estimate, which was 36% [17]; a study conducted in Addis Ababa, Ethiopia, which was 36.5% [18]; 49.7% in Arbaminch, Ethiopia [9]; Dessie, Ethiopia (34.5%) [8]; 48.8% in Enugu, Nigeria [19]; 81.5% in Tangail, Bangladesh [20]. However, the

Table IV
Binary logistic regression of MRSA predictors from patient with wound infection at NSH

Variables	MRSA (n=44)	MSSA (n=65)	COR (95%CI), *P*-value	AOR (95%CI), *P*-value
Gender				
Male	18	35	0.59 (0.27, 1.29),0.19	0.69 (0.12–2.40), 0.64
Female	26	30	1	
Age				
<15	5	8	1.09 (0.21,5.76),0.93	
15–30	18	31	1.02 (0.26,3.95),0.98	
31–45	12	11	1.91 (0.44,8.35),0.39	
46–60	6	8	1.31 (0.26, 6.64),0.93	
>60	4	7	1	
Education status				
No formal education	19	23	1.4 (0.52,3.78),0.52	
Primary	12	25	0.82 (0.29,2.31),0.87	
Secondary and above	10	17	1	
Occupation				
Government	6	9	1.17 (0.23,5.81), 0.86	
Housewife	9	8	1.97 (0.42,9.32), 0.40	
Farmer	11	18	1.07 (0.25,4.51), 0.93	
Daily labourer	9	14	1.13 (0.25,4.98), 0.88	
Merchant	5	9	0.97 (0.19,5.03), 0.97	
Student	4	7	1	
Marital status				
Married	10	10	1.15 (0.37,3.64), 0.82	
Single	10	22	0.52 (0.18, 1.50), 0.23	
Widowed	11	18	0.71 (0.25,2.03), 0.53	
Divorced	13	15	1	
Residence				
Rural	29	40	1.21 (1.79,2.76),0.08	3.93 (2.84–8.96), 0.79
Urban	15	25	1	
Site of Infection				
Leg	26	42	0.93 (0.15, 5.93), 0.94	
Feet	4	5	1.2 (0.13, 11.05),0.88	
Hand	3	4	1.13 (0.11,11.6), 0.93	
Head and neck	5	6	1.25 (0.15,10.7),0.85	
Back and abdomen	4	5	1.2 (0.13,11.05),0.88	
Other	2	3	1	
Type of wound				
Surgical wound	12	23	1.3 (0.34,5.05), 0.72	
Abrasion and skin tear	13	18	1.81 (0.46,7.04),0.40	
Burn wound	8	6	3.33 (0.69,16.02), 0.13	
Trauma	7	8	2.19 (0.47,10.21), 0.32	
Other	4	10	1	
Cause of wound				
Burn	9	16	0.75 (0.14,4.13), 0.75	
Surgery	11	19	0.77 (0.15,4.1), 0.77	
Gun Shot	4	8	0.67 (0.1,4.54), 0.72	
Bite	3	10	0.40 (0.06,2.89), 0.36	
Injury	14	8	2.33 (0.41,13.17), 0.35	
Other	3	4	1	
Wound depth				
Deep	26	25	2.31 (1.06,5.05), 0.04	4.63 (1.03–20.90), 0.03
Superficial	18	40	1	
Patient setting				
Inpatient	27	18	4.15 (1.84,9.37), <0.001	4.38 (1.05–18.29), 0.04
Outpatient	17	47	1	
History of hospitalisation				
Yes	18	26	0.56 (0.05, 1.21), 0.485	
No	36	29	1	

(*continued on next page*)

Table IV (*continued*)

Variables	MRSA (n=44)	MSSA (n=65)	COR (95%CI), *P*-value	AOR (95%CI), *P*-value
History of wound infection				
Yes	22	11	4.91 (2.04,11.81), 0.04	3.81 (1.23—11.82), 0.02
No	22	54	1	
History of antibiotic use				
Yes	21	8	6.51 (2.52, 16.79), 0.012	5.178 (1.333, 20.115), 0.03
No	23	57	1	
Co-morbidity				
Yes	21	27	1.29 (0.116,2.78), 0.88	
No	23	38	1	
Use of traditional Medicine				
Yes	20	16	2.55 (1.13,5.79), 0.024	1.12 (0.00—15.94), 0.99
No	24	49	1	

NSH, Nekemte Specialized Hospital; MSSA, methicillin sensitive S. aureus; MRSA, methicillin resistant S. aureus; COR, crude odds ratio; AOR, adjusted odds ratio; *P* level of significance; CI, confidence interval.

present result is higher than research done in different areas, which was 23.6% in Jimma [2] and Brazil (20%) [22]. The variations in prevalence might be due to variations in the socioeconomic status of the population studied, the study's duration, underlying patient condition and the wound type and the technique used for the identification of *S. aureus*.

In the current investigation, isolates had a 40.4% (44/109, 95% CI: 33.1%—47.7%) prevalence of MRSA. This result is comparable with a similar study conducted in Ethiopia in which the pooled prevalence of MRSA was 47% [23], 35.6% in Tikur Anbessa Specialized Hospital, Ethiopia [18], 37.43% in Yekatit 12 Hospital, Ethiopia [10], 45.1% in Debre Markos, Ethiopia [3], and a study from another country, which was 43% in Jacobabad, Pakistan [24]. In contrast to our results, a high prevalence of MRSA has been reported from Arba Minch, Ethiopia, which was 82.28% [9], 75% in Eritrea [25], 86% in Zaria, Nigeria [15], and 77.9% in Iran [26]. However, the result of the present study is higher than another research done in Ethiopia, which was 32.5% [27], 9.3% in Hawasa, Ethiopia [28], 8.8% in Addis Ababa, Ethiopia [20], 28.3% in Dessie, Ethiopia [8], 27% in Nigeria [29], 21% in Turkey [30]. These differences in the prevalence of MRSA have been attributed to differences in hospital environments, overcrowding, poor sanitation, and a lack of infection control policies.

The prevalence of VRSA among the total isolates of *S. aureus* was 7.3% (95% CI: 4.2%-10.4 %). This report is in line with a review from Ethiopia in which the pooled prevalence was 11% (95% CI: 4—20) [23]. Though the prevalence of MRSA in the present studies is lower than study conducted in different areas, which was 21.1% in Jimma, Ethiopia [21], 29.4% in Addis Ababa, Ethiopia [10], 14.1% in Debre Markos, Ethiopia [3], 44.5% in Nigeria [31], 13.8% in Egypt [32], 11.11% in Nepal [33], 20% in Bangladish [23], 13% in Pakistan [24]. The lack of broth microdilution test for vancomycin MIC which is the recommended method for vancomycin MIC in staphylococci probably underestimated VRSA prevalence in our study. In contrast to the current study, the prevalence of VRSA was 0% in Khartoum State, Sudan [34], 0% in Turkey [35], and 0.7% in Dhaka-Bangladesh [36]. Besides, based on a meta-analysis conducted by Wu *et al.*, was 5% in Asia, 1% in Europe, 4% in America, and 3% in South America [37]. This difference is probably due to different geographical locations. In the present study, 56.8% of MRSA isolates were resistant to Tetracycline, comparable with a study done in Addis Ababa, where the resistance to Tetracycline was 53.2% [38]. Conversely, the report is lower than the previous study conducted in Hawasa, Ethiopia, which was 69.2% [28] and 72.3% in the report Arba Minch, Ethiopia [9]. However, it is higher than studies conducted in from 25.4% of Nigeria [15], and 26% Turkey [35].

According to our findings, 72.7% of MRSA isolates were MDR, which was lower than reports from Jimma, Ethiopia, which was 86.2% [21], 88.5% from Hawasa, Ethiopia [28], 71.64% in Nigeria [31], and 81% in Tangial, Bangladesh [20]. However, it is higher than the study conducted in Dessie, Ethiopia, which was 69.2% [8] and 68% in Dhaka, Bangladesh [36]. The frequent usage of antibiotics to treat *S. aureus* without an appropriate medication may be the reason for the high antibiotic resistance in this research.

MRSA wound infections were substantially correlated with the depth of the wound, patient environment, history of wound infection, and antibiotic use within the previous six months in terms of potential risk factors. This finding was supported by the study conducted in Debre Markos, Ethiopia, in which the depth of the wound and history of wound infection were potential risk factors for prevalence of MRSA [3]. In contrast to this result, previous studies from Addis Ababa [18] and Arba Minch [9] Ethiopia showed that a history of wound infection was not linked to the prevalence of MRSA. Besides, similar to the current study, the antibiotic usage history was related to prevalence of MRSA in a study from Brazil [22]; on the contrary, the history of antibiotics use was not a significant risk factor in a study conducted in Cameron [16]. Further, in the present study, inpatients were four times more vulnerable to MRSA wound infection compared to outpatients, which was in agreement with a previous study conducted in Dessei, Ethiopia [8]. Cross-contamination of bacterial resistant strains in healthcare institutions may contribute to inpatients' susceptibility to MRSA.

Furthermore, the present study revealed that age, residence, sex, educational level and marital status were not predictors for the prevalence of MRSA, which is consistent with the studies performed in Arba Minch, Ethiopia [9], Hawasa, Ethiopia [28], Debre Markos, Ethiopia [3], Cameron [16], Brazil [22] and Korea [39]. Moreover, use of traditional medicine, comorbidity, site of infection, type of wound, and cause of wound were not significantly associated, which was correlated with studies from Debre Markos [3], Arba Minch [9], and Brazil [22].

Conclusions

A high incidence of *S. aureus* (28.4%), MRSA (40.4%), and VRSA (7.3%) in patients with wound infections was identified. The high percentage of MDR (72.7%) among the MRSA isolates observed in this investigation is of concern. The depth of the wound, the patient's setting, previous wound infections, and antibiotic treatment in the previous six months were significantly associated with MRSA wound infection. Therefore, to implement a hospital-acquired infection prevention program, recognised risk factors should be considered. Additionally, regular surveillance and a program for antimicrobial stewardship should be in place to gather crucial AST data that will be used for empirical therapy and future preventative measures.

Ethics approval and consent to participate

Ethical clearance was obtained from the Wallaga University ethical review committee with reference number WUERC/133/20 before the research was conducted. Besides, an official letter of cooperation was provided to Nekemte Specialized Hospital prior to data collection. Written informed consent was obtained from each participant before enrolment into the study. The confidentiality of study participants was kept. All methods were performed in accordance with the relevant guidelines and regulations.

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Author contributions

The published work was greatly influenced by the efforts of all authors, whether in the areas of conception, research design, implementation, data collecting, analysis, and interpretation, or in any combination of these. Additionally, they all committed to take responsibility for all aspects of the task, as well as co-authoring, amending, or critically evaluating the piece. They also gave their final permission for the version that would be published and decided on the journal.

Consent for publication

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Conflict of interests

None.

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